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THE USE OF RADIUM IN THE AEROTITIS CONTROL PROGRAM OF THE ARMY AIR FORCES

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LII

THE USE OF RADIUM IN THE AEROTITIS CONTROL PROGRAM OF THE ARMY AIR FORCES

Organization of the Army Air Forces Aerotitis Control Program began in May 1944 when the Air Surgeon called together ten otologists to discuss the problem of aerotitis and to consider the adoption of the technique of irradiating (with radium) hyperplastic lymphoid tissue about the eustachian tube orifices as a control measure. This technique was developed by Dr. Samuel J. Crowe, of Johns Hopkins, and had been used by him for a number of years.

In the United States aerotitis headed the list, week after week, the year around, of disorders due to flying. The number of men incapacitated by aerotitis interfered with the maintenance of the training program and caused reduplication of training and indoctrination in the low pressure chambers where simulated high altitude flying was taught.

In England during the winter of 1942-43, and in Italy during 1943-44, living and climatic conditions were responsible for frequent colds, marked lymphoid hyperplasia in the pharynx and nasopharynx and a high incidence of aerotitis. The situation overseas in 1943-44 is described by a letter from an Air Force Theatre Surgeon, "We constantly deal with flying personnel who have, or develop a chronically recurring aerotitis. Frequently this involves key personnel, whose utility to the Service becomes seriously impaired. The usual story is that a mission is flown, followed by subsequent grounding for several days or weeks because of aerotitis, and then the cycle is repeated. In the end, these men take up a lot of time of the Unit Surgeons, occupy hospital beds, and are not available for combat duty a third of the time."

Pathogenesis of Aerotitis.—Aerotitis is caused by inability to ventilate the middle ear during flight. Normally, equalization of pressure between the middle ear and the surrounding air is accomplished by swallowing, yawning or other acts that cause the eustachian tubes to open momentarily.

Study of the development of aerotitis in large groups of men indicates many predisposing factors, the most common of which is nasopharyngeal infection. Such infection usually causes an inflammatory reaction in the lymphoid tissue of the nasopharynx. The

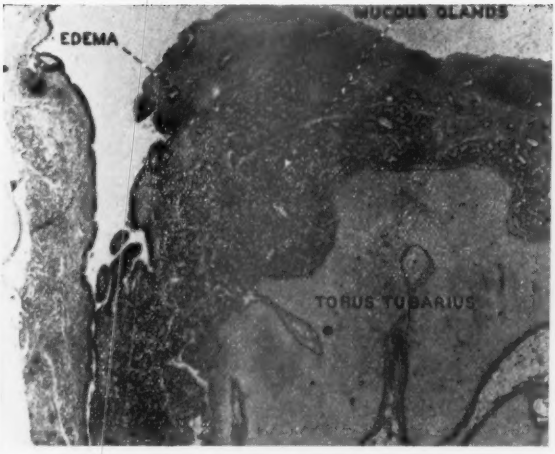

Fig. 1.—Acute catarrhal inflammation. Here there is hypersecretory activity of the mucous glands and goblet cells. There is subepithelial edema, cellular infiltration, and hyperplasia of lymphoid tissue. (From Farrior, J. B.: Histopathologic Considerations in Treatment of the Eustachian Tube, Arch. Otolaryng. 37:612, 1943.)

eustachian tube has, in addition to the mucous glands and large masses of lymphoid tissue at the pharyngeal end, a layer of diffuse lymphoid tissue beneath the epithelium throughout the length of the tube. Infection in the tissue at the pharyngeal orifice causes edema, hyperemia and engorgement of the mucous glands in this area (Fig. 1), which may extend into the tubal mucosa with a resultant thickening of the wall and narrowing of the lumen. Infected hyperplastic lymphoid tissue in the nasopharynx can be accurately diagnosed with the nasopharyngoscope. It is not the size but the location of the lymphoid tissue and the frequency of infections that is important. Enlarged adenoids in the absence of infection may cause no ear symptoms, while small infected nodules in the fossa of Rosenmüller, in and around the orifice of the tube (Fig. 1) or in the area between the tubal orifice and the posterior end of the middle turbinate may be the primary cause for repeated attacks of aerotitis, particularly in high altitude flying. In civilian practice, particularly in children, these changes may cause acute catarrhal or suppurative otitis media, but more commonly the only effect is impaired hearing which comes on gradually and is not associated with pain. The lack of acute ear

symptoms is due to long-continued partial or intermittent closure of the tube.

In contrast, partial or complete blockage of the eustachian tube, occurring during changes in barometric pressure associated with rapid descent in military aviation, prevents proper ventilation of the middle ear and is likely to produce the acute symptoms of aerotitis. Subjectively, aerotitis is characterized by a hearing loss of varying degree and duration. The blocking may be associated with pain. Objectively, there is retraction and congestion of the tympanic membrane and often hemorrhage into its layers. In severe cases an outpouring of serum or blood into the middle ear cavity may occur and in rare instances a traumatic perforation of the drum is seen.

Nasopharyngoscopic examination of 1000 bomber crew members at Mitchel Field, New York, revealed that 31.5 per cent of these young, healthy adults had hyperplastic lymphoid tissue about the eustachian tube orifices. These men had completed combat crew training, including high altitude flying. A striking correlation was found between the amount of lymphoid tissue around the tubal orifice and the incidence of aerotitis during the training period. Of 170 men with a definite history of aerotitis, two out of three had excessive lymphoid tissue around the tubal orifices; and of 300 with a history of slight difficulty clearing the ears, one out of two had excessive lymphoid tissue around the tubal orifices. In marked contrast were the findings in 530 men who had had no trouble clearing their ears during flight; only one in sixteen in this group had excessive lymphoid tissue near the tubal orifices. Similar correlations between aerotitis and nasopharyngeal lymphoid tissue had already been reported by Fowler,[1] who, while attached to an Army general hospital in England, obtained radium applicators from British sources. He examined and treated a group of Air Force personnel suffering with recurrent aerotitis, and succeeded in restoring a substantial number to flying status.

Commonly used procedures for the treatment of acute aerotitis consist of the local use of shrinking agents to the nasopharynx and nose, local heat to the affected ear, and tubal inflation. These measures may relieve the acute symptoms and hasten the resolution, but if infected lymphoid tissue is present in the fossa of Rosenmüller, on the torus tubarius, or around the pharyngeal orifice of the eustachian tube, recurrence is likely, especially after high altitude flying.

Rationale for the Use of Radium.—It has been known for 40 years[2] that lymphoid tissue, next to sex cells, is the most sensitive

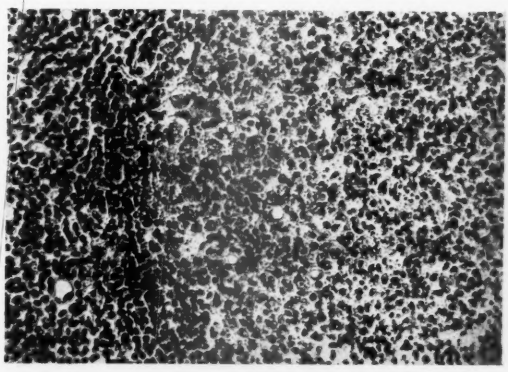

Fig. 2.—Photomicrograph of part of a germinal center in adenoids removed the day after a radium treatment.

tissue in the body to irradiation. In the nasopharynx, because lymphoid tissue is an integral part of the mucous membrane, all of it cannot be removed surgically. The safest, simplest and most effective way to remove such surgically inaccessible lymphoid tissue is by irradiation with a radium applicator. This has been proven by the results obtained at the Johns Hopkins Hospital where for many years this method has been in use by Dr. Samuel J. Crowe et al[3-5] in the treatment of hyperplastic lymphoid tissue in children with impaired hearing. If the dosage is of proper strength and the treatments spaced at proper intervals, lymphoid tissue usually disappears, leaving a smooth, normal-appearing mucous membrane. The only histologic changes seen in lymphoid tissue removed from the nasopharynx 18 to 24 hours after a single irradiation treatment are in the germinal centers (Fig. 2). The mature lymphocytes, the epithelium, vascular endothelium and all other tissues are normal in appearance. In the germinal centers cellular debris and large phagocytes containing fragmented cells are the prominent features; no mitotic figures are seen. Biopsy made one week after irradiation shows that recovery is well under way; mitotic figures are again seen and much of the cellular debris has been removed. These findings indicate that the dosage used destroys only the cells undergoing mitosis at the time of the treatment. This interrupts the normal cycle of replacement of mature lymphocytes. The size of a lymphoid nodule depends largely on the number of mature lymphocytes. These mature lymphocytes are constantly being used up, discarded

and replaced by mitosis of the germinal center cells. Repeated irradiation treatments prevent replacement of lymphocytes and thus cause a gradual and progressive reduction in size of the tissue treated.

Treatment of hyperplastic lymphoid tissue in the nasopharynx with deep x-ray therapy is advocated by some. This method, however, is much more time consuming and complicated than treatment with radium applicators passed along the floor of the nose and placed in contact with the hypertrophied tissue near the tubal orifice. One of the chief objections to the use of x-ray treatment is that from 50 to 60 per cent of the rays delivered at the surface of the skin are absorbed before they reach the nasopharynx. It is therefore necessary to deliver a dosage on the skin that is twice the amount required to relieve the condition in the nasopharynx. This necessitates fractional treatment through several different portals—a complicated and time-consuming procedure. The results are unsatisfactory unless the cross-firing accurately concentrates the rays at the tubal orifices. An additional objection, particularly in children, is the incidental irradiation of the ossification centers at the base of the skull. For military personnel the simple and readily portable radium applicators offer a distinct advantage over deep x-ray therapy which is ordinarily available only at Army general hospitals.

The Air Surgeon, after consideration of the report by the original group of ten otologists who recommended the adoption of nasopharyngeal irradiation as a control measure for aerotitis, authorized the special training of additional groups of otologists in order to expand the program in this country and overseas. To evaluate results in the various theatres, standard methods of history taking, of examinations, of interpretation of findings and technique of treatment were agreed upon.

Selection of Patients for Treatment.—All patients were given a complete ear, nose and throat examination and a history of past performance of ear-ventilating function was obtained and recorded on carefully planned forms. The nasopharyngoscope was employed by all the examiners to determine the presence or absence of hyperplastic lymphoid tissue about the eustachian tube orifices. A diagrammatic sketch of the nasopharynx with particular emphasis upon the location of the lymphoid tissue was made at the time of each examination and was later used as a basis for determining objective improvement.

In combat areas the men selected for treatment were almost exclusively those who had had definite aerotitis or were having difficulty in clearing their ears. In the United States men selected for treatment

Fig. 3.—Nasopharyngeal radium applicator.

at the various clinics included many who had experienced no difficulty in clearing their ears. In this country many men had had relatively little flying experience. Such men, it was felt, could not judge with accuracy their own ear-ventilating ability under conditions of flight. Consequently a negative history at this stage had little significance and selection for treatment was based upon the presence of hyperplastic lymphoid tissue in and about the eustachian tube orifices in such a location as to make them more susceptible to aerotitis.

The problem of a control study was given serious consideration by those responsible for the program. The over-all need, however, for treating fliers with ear-ventilating difficulties was so acute that no large scale control study was undertaken. At Westover Field, Massachusetts, 922 men with clear eustachian orifices were observed for about six months in an effort to evaluate irradiation therapy as a prophylactic measure. The only other control study undertaken was in the Eighth Air Force in England, where for a few months observations were made on 66 men with positive histories of aerotitis and with excessive nasopharyngeal lymphoid tissue who were not treated.

Technique of Treatment.—The source of the irradiation was two nasopharyngeal applicators containing radium. Each applicator consisted of a radium-containing chamber brazed to a wire handle. The chamber was made of monel metal, 2 cm. long, had an outside diameter of 2.3 mm., an inside diameter of 1.7 mm., a wall thickness of 0.3 mm. and contained approximately 50 mg. of radium sulfate. The radium-containing chamber is brazed to the handle to prevent the possibility of its being broken off and swallowed or aspirated.

The applicators were inserted into the nasopharynx and allowed to remain in place for 6.6 minutes. This gave a dosage of approximately 1 gm. 20 seconds. Later in the program the dosage was increased to 1 gm. 25 seconds (8.5 minutes in each side

of the nasopharynx). The heavier dose was found to be more effective and yet within the limits of safety. With the 0.3 mm. filtration used in this applicator the rays emitted consist of approximately 30 per cent beta rays and 70 per cent gamma. Only those rays absorbed by the tissues are of therapeutic value. Practically all of the beta rays are absorbed, most of them in the first 3 mm. of tissue. In contrast, only 6 per cent of the gamma rays which pass through the filter are absorbed by the tissues of the nasopharynx. With these applicators 8.5 minutes' exposure is the maximum that may be given with safety. Careless timing or otherwise increasing this dosage will result in undesirable reactions. In clinics possessing only one applicator, one side may be treated for 8.5 minutes, then the other for a similar period immediately afterwards.

With the patient lying on a cot or bed, an applicator is passed along the floor of each side of the nose into the nasopharynx. Ordinarily the topical anesthesia used for the nasopharyngoscopic examination suffices to make the insertion of the applicators painless. Proper placement of the applicator is most important. The nasopharynx varies in size. The middle (not the end) of the radium-containing chamber should be in direct contact with the tissue in the fossa of Rosenmüller or at the orifice of the eustachian tube. The exact location and depth from the external nares to the area to be treated can be determined by a preliminary examination with the nasopharyngoscope in one side of the nose and a calibrated rod or dummy applicator in the opposite side. The applicator should never be bent since this may lead to leakage of radon. When in place, it may be fixed with a suitable clamp or adhesive tape.

As a rule, a course of three treatments is given at intervals of not less than 25-30 days. It is inadvisable to shorten the intervals between treatments because undesirable reactions may occur. Treatment should not be given if the patient has an acute upper respiratory infection. In the presence of a subacute nasopharyngitis one-half of the usual dose should be given at that time and five days later the other half. The full dosage at one sitting, however, is always more effective than the same dosage given in fractional amounts over a period of a week. The individual response to the effects of the radium varies considerably. In some subjects a marked regression of the lymphoid tissue is noted after one or two treatments; in others as many as four or five treatments are required. Under combat conditions overseas and the necessity for fulfilling training schedule commitments in this country, many patients received only one or two treatments.

The question of the danger of excessive irradiation to those giving the treatments was carefully considered. The following precautions were adopted from the handbook "Radium Protection", published by the National Bureau of Standards.[6] Their use has successfully prevented any evidence of overexposure to radium in clinic personnel, some of whom have given over 2,500 treatments. The best protection is distance. The radium treatment rooms were 20 or more feet from the examining rooms. During a treatment the operator remained away from the vicinity until the treatment was completed and the radium was to be returned to its lead case. The applicators were handled as briefly as possible, and when handling them they were held as far from the body as possible. Under no circumstances were the applicators cleaned with cotton held in the hand. To clean the applicator a soft brush fastened to the sink was used. The thumb and finger should not be used to elevate the tip of the patient's nose while inserting the applicator. Monthly blood counts will reveal any susceptibility of the worker's white blood cells to irradiation. If any deficiency is found appropriate steps should be taken. A paper clip over a dental film in the pocket will roughly measure the amount of irradiation being absorbed. A sharp image of the clip on the film on a darkened negative in two weeks' time indicates overexposure.

Results of Treatment.—The experience of 12 months of using nasopharyngeal irradiation in five Air Forces participating in the Army Air Forces Aerotitis Control Program showed it to be ideally suited for military use. It required very little time, interfered very little with combat or training schedules, and most important did not interrupt flying activities. In the five Air Forces participating in the Aerotitis Control Program, 14,345 men received an initial examination and 6,881 men were selected for treatment. Using the technique described in the foregoing, 14,045 individual treatments were given. No reactions more severe than a mild stuffiness of the nose, slight sore throat or sensation of a head cold were observed, and these only in a very small proportion of the men treated. Not a single instance of burn or ulceration of the nasopharyngeal or nasal mucous membrane was observed by any of the officers engaged in the program.

One of the most difficult problems was the evaluation of the over-all results of the aerotitis control program. The various working conditions under which the clinics were conducted necessarily resulted in different approaches to the subject. Climatic conditions were severe in England, mild in Florida. At Mitchel Field, New York, only men with severe recurrent attacks of aerotitis were treat-

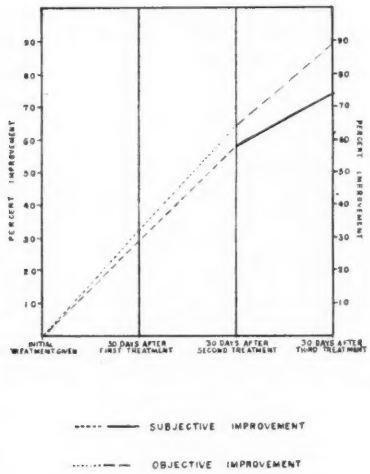

Fig. 4.—Subjective and objective improvement after two and three treatments in 636 men with a past history of aerotitis.

ed, while at Westover Field, Massachusetts, the study was mainly of a prophylactic nature. In Italy great distances between units had to be covered. Throughout the entire project the rapid shifting of flying personnel made follow-up studies extremely difficult.

The outstanding over-all finding noted by each individually operating clinic was that the subjective improvement paralleled objective improvement. Subjective improvement was judged on the basis of the individual flier's statement that he was having less difficulty ventilating his middle ears following the treatment. Objective improvement was based on the medical officer's findings of reduction in the amount of lymphoid tissue after successive irradiation treatments. Although improvement in many patients was noted after one or two treatments, data obtained from examinations made 30 days or more after the three-treatment series had been completed was considered the most valuable. In the five Air Forces together, 636 men with a positive history of ear-ventilating difficulty were available for examination 30 days after their second and third treat-

ments. Objective and subjective improvement in these men was noted (Fig. 4) after the second treatment and became even more apparent after the third. The high percentage of subjective improvement which accompanied the reduction of hyperplastic lymphoid tissue about the eustachian tube orifices is conclusive proof that removal of this tissue by irradiation eliminates a major cause of aerotitis.

Other aspects of the evaluation of results of therapy are found in the individual reports that are appended. Hendricks and Lieberman in the First Air Force found, in a study of 778 men with hyperplastic lymphoid tissue about their eustachian tube orifices, that irradiation therapy was effective in the prophylaxis of aerotitis. Under the same conditions of living and flying, the aerotitis rate (per 100 flights at high altitude) in the group selected for treatment was twice that of a control group of 992 men with clear tubal orifices. After treatments were complete, the rates per 100 flights in the treated and the control groups were practically identical.

The effectiveness of nasopharyngeal irradiation in men with recurrent attacks of aerotitis is shown in the results obtained in the First, Eighth, Twelfth, and Fifteenth Air Forces, where observations were made 30 days or more after the third treatment. Weymuller, working in the First Air Force at Mitchel Field, New York, found in 52 men with recurrent attacks of aerotitis that 84 per cent showed subjective improvement following treatment and 88 per cent showed objective improvement. Collins, Eschenbrenner and Lyle in the Eighth Air Force, based in England, Trapasso in the Fifteenth Air Force in southern Italy, and Mikell in the Twelfth Air Force based in northern Italy, in a total of 240 cases of recurrent aerotitis treated with radium, reported subjective improvement in 80 per cent and objective improvement in 96 per cent. Glauber, Smith and Earl in the Third Air Force examined their cases at the time of the third treatment but were unable to follow them subsequently. They report 95.2 per cent objective improvement and 90.5 per cent subjective improvement.

The value of irradiating minimal amounts of lymphoid tissue located in critical areas about the tubal orifices was shown by Mikell in the Twelfth Air Force and by Collins, Eschenbrenner, and Lyle in the Eighth Air Force, who studied the effect of treatments on 66 men in this category who had had previous ear-ventilating difficulties. After completion of therapy, subjective improvement was reported by 55 of these men. This emphasizes the fact that small amounts of

lymphoid tissue about the tubal orifices may seriously impair the ventilating ability of the eustachian tube.

Analysis of the patients who failed to improve after completion of their treatments revealed the following facts. Some men exhibited huge masses of lymphoid tissue in the nasopharynx. In these individuals irradiation alone was insufficient to bring about clinical improvement and surgical removal of the main mass of tissue combined with irradiation would have been more desirable. Others exhibited lesser amounts of lymphoid tissue which were resistant to irradiation. Additional radium treatments in these cases would probably have produced the desired results. There remained another group of men who showed a definite decrease in the amount of lymphoid tissue after treatment, but no improvement in ear-clearing ability was noted. The reasons for the failure of this group to improve subjectively are varied. In some a definite psychological element was present. In others, various factors such as nasal allergy, chronic sinusitis and hypertrophy of the posterior ends of the turbinates were found to be contributing causes for lack of improvement. In a small group of men, no adequate explanation for lack of improvement could be determined.

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IRRADIATION PROGRAM IN THE FIRST AIR FORCE

The Irradiation Program in the First Air Force was conducted at three heavy bomber training bases and one staging base. At the training bases the combat crews were schooled for 10 to 14 weeks during which time they flew high and low altitude, day and night, and bombing, gunnery, and formation missions. At the staging base each crew was processed medically and administratively, and given new equipment prior to overseas departure. At each of the training bases, the incoming men were screened, and an attempt was made to give the necessary amount of irradiation therapy before the completion of their training. The training schedule was altered to suit changes in the weather, changes in the curriculum, etc. These changes, in many instances, precluded the possibility of completing the full series of treatments and post-treatment check-ups. A clinic, therefore, was set up in the staging area at Mitchel Field, in order to treat those individuals who had not had the full course of treatments before being ordered to combat duty. In addition to this, all problem cases at bases other than those in which an irradiation clinic was active were referred to Mitchel Field.

Total number of examinations, First Air Force: 9,760.

Total number of treatments, First Air Force: 7,824

No reactions were encountered and flying training was not interrupted because of treatments.

The following personnel conducted the program in the First Air Force: John Hendricks, Captain, M. C.; Alfred T. Lieberman, Captain, M. C.; Edward Lyman, Captain, M. C.; John McMurray, Captain, M. C.; Paul L. Magnuson, Major, M. C.; Ernest A. Weymuller, Major, M.C.

LIII

ACTIVITIES OF THE IRRADIATION CLINIC AT WESTOVER FIELD, MASSACHUSETTS

Captain John E. Hendricks

and

Captain Alfred T. Lieberman

Medical Corps, Army of the United States

Aerotitis is caused by failure of the middle ear and the eustachian tube to ventilate properly during flight, especially during descent. Reports from flying training commands in this country and combat areas abroad have shown this condition to be a major cause of loss of flying time. Treatment of acute aerotitis is palliative and necessitates grounding of the individual until his ear-ventilating ability is restored. Upon recovery, the men frequently are subject to recurrences. In an effort to reduce loss of flying time to a minimum from this cause the Air Surgeon, in 1944, established a control program aimed at the prevention of aerotitis. As a part of this control program an Irradiation Clinic was established at Westover Field, Massachusetts, in September 1944.

This base was a central assembly point for heavy bombardment crew members who had completed their training at various specialty schools as pilots, bombardiers, radio operators, gunners, etc. At Westover Field complete crews were formed and then given eight weeks of combat flying training prior to shipment overseas. This was the longest period these men remained together at one point, and after the initial screening examination there was just enough time to give three irradiation treatments when indicated.

The excellent cooperation received from the tactical section of the training department throughout the study greatly facilitated the scheduling of crews for their examinations and treatments.

Personnel assigned to the project were two medical officers (otolaryngologists) specially trained in the technique of nasopharyngeal irradiation, two army medical corpsmen, and one civilian clerk-typist.

From the Irradiation Clinic, 112th Army Air Force Base Unit, Westover Field, Mass.

Fig. 1.—Showing the type of building used for the Irradiation Clinic. Its length allows the radium cabinets and radium treatment rooms to be distantly separated from the offices and the examining rooms. The greater the distance from the radium, the greater is the safety for the personnel.

The physical facilities of the clinic and the manner of its operation are shown in the illustrations in Figs. 1-6.

One of the earliest reports of aerotitis was made by Scott,[1] in 1920. He described the retraction, hyperemia, and presence of fluid behind the tympanic membrane. Later Armstrong and Heim[2] in a comprehensive study of the condition more fully described the disease entity and gave it the name of "aero-otitis media". The British in the majority of their writings refer to the same condition as "otitic barotrauma."

The chief symptoms of aerotitis are sensations of fulness and frequently pain in the ear occurring during or soon after descent from a flight. When the patient is unable to relieve this fulness he states that his ears are "blocked" or "plugged." The patient also may complain of a certain amount of impaired hearing and often of popping or crackling sounds in his ears.

On examination the most common pathologic findings are retraction and hyperemia of the tympanic membrane. The severity

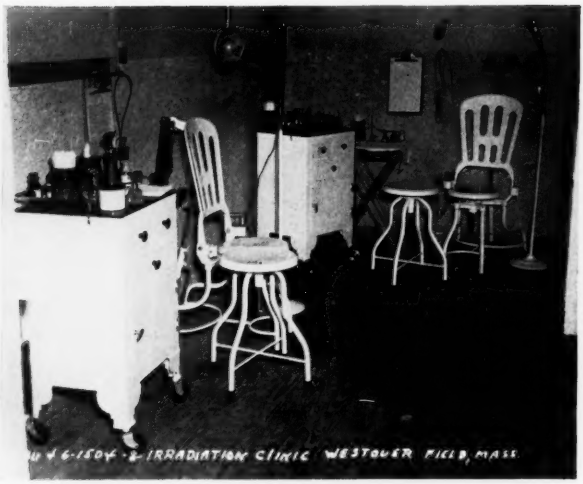

Fig. 2.—Showing the arrangement of the examining room. Two medical officers can examine (and treat, when necessary) ten men an hour. The medical officers alternate turns each hour in giving irradiation therapy to minimize the radiation they themselves absorb.

Fig. 3.—Showing a medical officer using the nasopharyngoscope. With this instrument direct visualization of the entire nasopharynx is possible. The nose is prepared for examination by spraying it lightly wth a 5 per cent butyn solution. A cotton swab moistened with 20 per cent cocaine solution is .hen passed along the floor of the nose in the path to be followed by the nasopharyngoscope. The examination is entirely without pain and requires between seven and eight minutes.

Fig. 4.—Showing a patient receiving a treatment. One radium applicator is in place and the second is about to be inserted. Two rubber gloves protect the hands from the caustic beta rays while the rubber apron (leaded) will absorb only a fraction of the more penetrating gamma rays. The white cabinet contains the lead radium chamber. The applicators are removed from the glass tubes containing alcohol, rinsed in the sink, dipped in the lubricating jelly (in the glass graduate on the shelf), and placed in the patient. When removed, the applicators are rinsed, rubbed against the scrub brush in the bracket by the sink, rinsed again, and replaced in the alcohol tubes in the lead case. The arrangement of the room is such that a minimum number of steps and seconds are used in handling the applicators. The table at the left contains equipment for using the nasopharyngoscope for checking the position of the applicator when necessary.

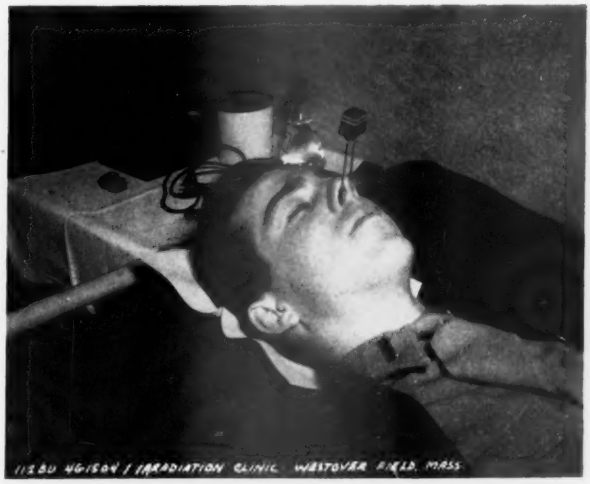

Fig. 5.—Showing a patient with both applicators in place for eight minutes and thirty seconds. The plastic block is simply a thimble over the handles of the applicators which forces them together. This forces the radium bearing tips laterally towards each eustachian tube orifice.

Fig. 6.—Showing the semiportable radium cabinet designed by this clinic. The lead radium chamber is housed in the top of the cabinet. Additional protection is afforded by a 3" x 6" lead desk in the lid and another on the shelf directly under the chamber.

depends upon the degree of trauma sustained. Hemorrhage into the layers of the tympanic membrane or into the middle ear mucosa may occur, and frequently fluid is found in the middle ear. The Valsalva test is usually negative, later becoming positive as the tubal obstruction is relieved. If the hearing is tested, some deafness is usually demonstrated.

History of an acute upper respiratory infection at the time of the flight is nearly always obtained from the patient, and evidence of this is usually seen on examination of the nose and throat.

The findings and symptoms of acute aerotitis usually disappear within a relatively short time, and no permanent sequelae have been observed at this clinic. Complications are rare, and for the most part consist of otitis media or perforation of the tympanic membrane.

The diagnosis of aerotitis in every case included in this report was based upon symptoms and positive otoscopic findings, combined with a history of onset during or soon after aerial flight.

During the period of September 10, 1944, to June 1, 1945, 3,525 airmen in combat crew training at Westover Field were examined. Hyperplastic lymphoid tissue in or near the eustachian tube ostia was the basis for the selection for irradiation treatment in 44.3 per cent. In this treated group a past history of aerotitis was two and a half times as frequent as in those rejected for treatment. Selection or rejection of cases for treatment was on the basis of findings in the nasopharynx, plus the past history regarding the ventilating ability of the eustachian tube. At this clinic more importance was attached to findings in the nasopharynx than to the histories, because some men had had very little high altitude flying. For these men, a negative history was of little significance, because aerotitis is known to occur much more often after flights above 20,000 feet than after flights at lower altitudes. Also a small percentage of men with a positive past history of aerotitis had no abnormalities in the nasopharynx. Obviously these men were not proper candidates for irradiation treatment.

The degree of lymphoid hyperplasia is important, but the location of such tissue is of greater importance. Large masses of lymphoid tissue (Fig. *7b*, *7c*) often give rise to ventilating difficulties, but small nodular or a diffuse granular lymphoid hyperplasia in critical areas also may impair tubal ventilation. Of particular importance is the fossa of Rosenmüller region and the tubal orifice itself. It is frequently observed that the entire torus is covered with a hyperemic, granular-looking layer of lymphoid tissue, arising from the fossa of Rosenmüller and sometimes extending into the orifice of the tube (Fig. *7d*).

Nodular lymphoid tissue at the upper pole of the fossa of Rosenmüller, near the posterior end of the middle turbinate, or on the lip of the torus itself, is a major factor in impairing tubal ventilation particularly in the presence of an upper respiratory infection. In the nasopharyngoscopic examination, it is important always to inspect this area. Many men in the group not treated had lymphoid hyperplasia in the midline and some gave a past history of aerotitis, but in every one the eustachian tube ostia presented a normal-looking lumen, with smooth mucous membrane on the torus and little or no lymphoid tissue in the fossa of Rosenmüller (Fig. *7a*).

To determine the relation of lymphoid tissue in the nasopharynx to other ear, nose, and throat findings, a detailed study was made of

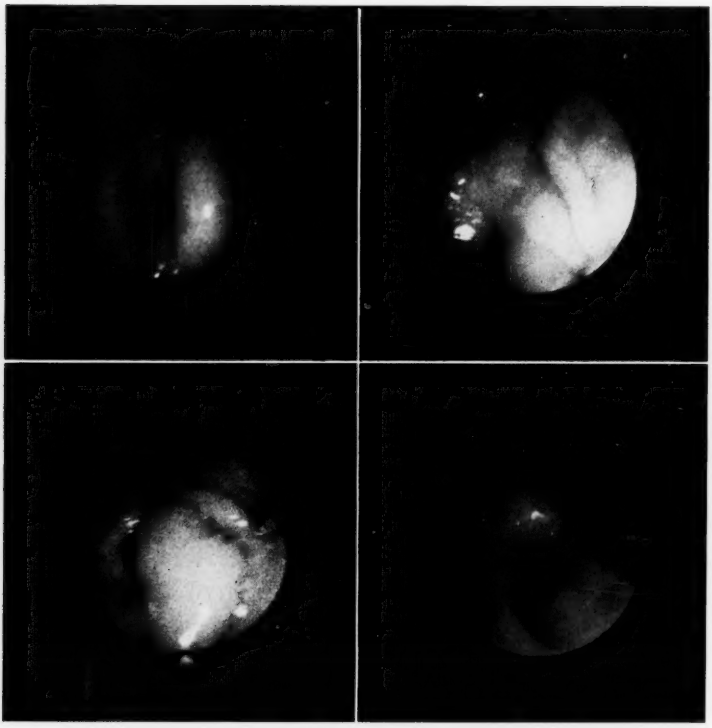

Fig. 7.—Photographs of the orifice of the right eustachian tube of four aviators, as seen through a nasopharyngoscope. The left upper picture shows a normal orifice, the others show various degrees of lymphoid hyperplasia.

two groups of trainees totaling 1,069 men who were examined in January and February 1945.

Table 1 shows that many men in the group selected for treatment had other conditions associated with tubal malfunction, such as a history of otitis media, difficulty in ventilating the middle ear, and abnormal tympanic membranes. In the untreated group, these conditions were less frequent.

There was no definite relation between the presence or absence of tonsils and the occurrence of hypertrophied lymphoid tissue in the nasopharynx. Most men, however, with hypertrophied lymphoid

TABLE 1.—ANALYSIS OF EAR, NOSE, AND THROAT FINDINGS IN 1069 SUBJECTS

	Rejected for Treatment 543 Men (50.8%)	Selected for Treatment 526 Men (49.2%)	Entire Group 1069 Men (100%)
Past History of:			
Otitis media	6.6%	10.6%	8.6%
Difficulty ventilating ears in flight	6.6	16.9	11.5
Difficulty ventilating ears in altitude chamber	6.4	25.8	10.3
Ears:			
Scarred membrani tympani	12.3%	21.9%	17.0%
Healed perforation (old)	2.0	1.1	1.6
Retracted Shrapnell's membrane	3.1	7.9	5.5
Retracted pars tensa	4.9	12.3	8.6
Nose:			
Clinical evidence of sinusitis	1.1%	0.1%	0.6%
Septal deviation	6.8	11.2	8.9
Pharynx:			
Tonsils present	50.3%	49.0%	49.7%
Lateral pharyngeal bands	11.9	30.9	21.3
Lymphoid tissue on the posterior wall	16.8	35.9	26.1
Nasopharynx:			
Abnormal tubal orifices	2.9%	76.2%	39.0%
Hyperplastic lymphoid tissue in the fossa of Rosemüller	5.9	98.3	55.5
Hyperplastic lymphoid tissue on the posterior wall (adenoids)	11.0	63.7	36.9
Valsalva Test:			
Positive in one or both ears	24.9%	32.1%	28.4%

tissue on the posterior and lateral pharyngeal wall also had hypertrophied lymphoid tissue in the nasopharynx.

In our experience the results of the Valsalva test varied too much to be a reliable criterion of eustachian tube patency.

The dosage of radium used (1 gm. 20 seconds to each side of the nasopharynx) was based on years of clinical experience at the Johns Hopkins Hospital and was employed at this clinic for the first six months. Later a slightly larger dose (1 gm. 25 seconds) was substituted on the basis of unpublished tests by Dr. Curtis F. Burnam.

This dosage is the maximum still within the limits of safety. Individuals vary in their reactions to irradiation, as they do to exposure to sunshine.

The therapeutic effect of a single dose may be modified greatly by the reparative powers of the tissue. A unit dose given at one sitting produces more effect than the same total dose given in daily fractions in a period of a week. The recovery period of the nasopharyngeal lymphoid tissue after moderate irradiation varies from three to four weeks, therefore the interval between treatments at Westover Field was fixed at 25 days.

As a rule three treatments are adequate, but in refractory cases four or five may be necessary. If the nasopharyngoscopic examination indicates that additional treatments are necessary, they also are given at intervals of 25 days. If adenoids are very large, a combination of surgical removal and immediate irradiation of each side of the nasopharynx is more effective than three or four irradiation treatments alone. Edema always follows irradiation. For this reason it is advisable to omit treatment when the patient has an acute nasopharyngitis. In subacute nasopharyngeal infection, half the usual dose is given at the first sitting, and the other half five days later. It has been the practice in this clinic to treat such patients with nose drops of 2.5 per cent sulfadiazine in ethanolamines solution (Pickrell's solution) in the manner advocated by Crowe.[3] The patient is instructed to put one-half medicine dropper of this solution into each nostril and allow it to flow backward along the floor of the nose into the nasopharynx and pharynx. This should be repeated ten to twelve times a day for three days, and four to six times a day for an additional week. The use of this medication lessens the severity of these infections and permits completion of the irradiation therapy at an earlier date.

This clinic was in operation for ten months beginning in September 1944. The following table shows the number of examinations and treatments given during this period.

TABLE 2.—SCOPE OF AEROTITIS PROGRAM AT WESTOVER FIELD, MASSACHUSETTS

Total number of men examined	3525
Number of initial treatments given	1562
Total number of treatments given	5065
Men observed 30 days or more after three treatments	778

Evaluation of the results of treatment at this clinic was somewhat difficult. It was decided that the evaluation of the treatment

should be based upon (a) objective changes observed in the nasopharynx, (b) subjective effects noted by the patient, and (c) the effects of the treatments on the incidence of aerotitis. Since it was known that the effects of irradiation on lymphoid tissue is apparent for weeks and even months after an exposure, it was decided that no final evaluation should be made until a patient had received a minimum of three treatments and an interval of 25 days had elapsed after the third treatment. With these criteria, certain difficulties were encountered. Chief among them was the fact that the follow-up period for many of the men in the earlier groups was too short for adequate observation. Others received only one or two treatments and then were not seen again for various reasons (Table 3A). Another difficulty was that a large proportion of our treated series were selected solely because they had hyperplastic lymphoid tissue in or about their eustachian tube orifices and no past history of aerotitis. While objective changes in the nasopharynx could be observed in these men, it was difficult for them to appreciate any subjective improvement attributable to the treatments.

In view of these facts, the only evaluation of the treatments that could be made during the first four months of operation was the objective change observed in the lymphoid tissue at the time of the third treatment. During this period of time, trainees, did not remain here long enough after three treatments to determine subjective improvement. These findings are shown in Table 3B.

Additional information regarding the value of the treatments was sought and the next method tried was a special altitude chamber test run* on 20 men who had had previous attacks of aerotitis and who had received three irradiation treatments. Despite the fact that this test was made an average of only 17 days after the third treatment had been given (before we considered the treatments complete), 18 out of the 20 successfully completed the chamber run. Although the results were encouraging this method of evaluation proved impractical because of the various administrative factors involved and was later discarded.

As the war in Europe neared its end, the training period of bomber crews at this station was prolonged. Seven hundred seventy-eight treated men remained under our observation for two to four

*The test run was a simulated ascent to 38,000 feet preceded by a check run to 5,000 feet. At 38,000 feet a 15 minute adjustment period was allowed; the rate of descent was 3,000 feet per minute to 20,000 feet and then 2,000 feet per minute to ground level.

TABLE 3.—EVALUATION OF RESULTS OF IRRADIATION THERAPY IN 1556 MEN

	EXAMINATION 30 DAYS AFTER	TYPE CASES	NUMBER MEN	OBJECTIVE IMPROVEMENT YES	OBJECTIVE IMPROVEMENT NO	SUBJECTIVE IMPROVEMENT YES	SUBJECTIVE IMPROVEMENT NO
A	First Treatment	Negative Past History	110	No available for examination			
		Positive Past History	52				
		Recurrent	9				
B	Second Treatment	Negative Past History	401	% 65.7	% 34.3		
		Positive Past History	166	66.8	33.2	Insufficient elapse of time for subjective evaluation	
		Recurrent	8	62.5	37.5		
C	Third Treatment	Negative Past History	593	% 90.8	% 9.2	% 33.8	% 66.2
		Positive Past History	150	87.3	12.7	54.6	45.4
		Recurrent	35	100.	0	51.4	48.6
			778	90.7%	9.3%	54%	46%

months after receiving their third treatment. On these men observations were made on subjective and objective changes as well as on the effect of treatments on the rate of aerotitis.

Objective Changes Observed in the Nasopharynx.—In 778 men re-examined about 60 days after completion of their course of treatments, 90 per cent showed a definite reduction in the amount of lymphoid tissue in the nasopharynx as compared to their original examination (Table 3). The tubal orifice and the fossa of Rosenmüller showed the greatest decrease; the midline, the least. This is due to the placing of the applicators and the dosage. Seventy-three (9.3 per cent) showed no objective improvement. The majority of these had huge midline masses of adenoids. Surgical removal of the adenoids plus irradiation would have been better treatment, but would have interrupted their flight training.

Subjective Changes Noted by the Patients.—At the time of the final examination each treated subject was questioned regarding subjective reactions to the treatments. Their responses are summarized in the following table:

TABLE 4.—SUBJECTIVE EFFECTS OF TREATMENT IN 778 PATIENTS

Ears "clear easier"	301	(38.6%)
No change in ability to "clear ears"	477	(61.4%)
Less nasal congestion and discharge	48	(6.1%)
Fewer head colds than usual	113	(14.5%)
Mild after-effects of treatments	97	(12.4%)
No after-effects of treatments	681	(87.6%)

In the total of 778 treated subjects, 185 had a prior history of difficulty in ventilating their ears. Greater ease in clearing their ears was noted by 100 or 54 per cent of the men in this group. In the remaining 593 who had never experienced difficulty in clearing their ears, there were 201 or 33.8 per cent who declared that their ears cleared with less effort than before. The after-effects of the treatments noted by the patients were mild but varied. The more common complaints were: a mild head cold for one day after a treatment mild throat irritation, nasal stuffiness, vague headache, discomfort in the nose and a mild earache. It is the opinion of the authors that these complaints were more the result of the local anesthesia and the examination than an actual irradiation effect. In over 2,300 separate treatments given to the three groups under consideration, not one

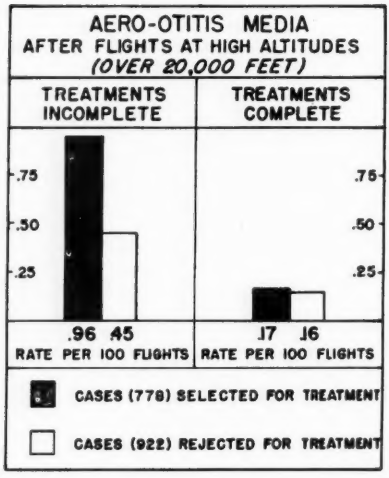

Fig. 8.—Rate of aerotitis per 100 flights at altitudes over 20,000 feet for treated and untreated men.

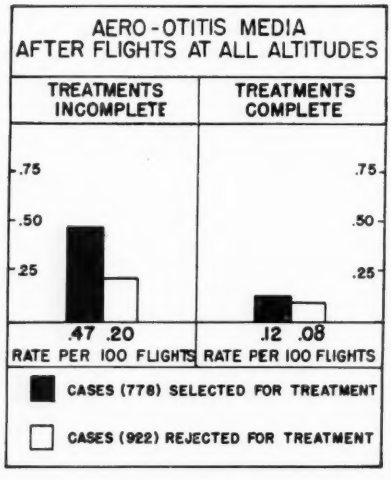

Fig. 9.—Rate of aerotitis per 100 flights at all altitudes for treated and untreated men.

The data in Figs. 8 and 9 are presented as rates per 100 man-flights. To obtain these figures:

1. The total number of missions flown was multiplied by 10, the number of men per crew;
2. The result was proportioned between the treated and the control group in the ratio of the number of men in each;
3. The number of cases of aerotitis in each group was divided by the number of man-flights for the group and the result multiplied by 100.

reaction occurred with severity of a degree sufficient to require discontinuance of treatments. Since the establishment of this clinic a total of over 5,000 individual treatments have been given with no reaction more severe than those described above.

Effect of Treatments on the Incidence of Aerotitis.—The observations on 1,700 men, who were held over at Westover Field from two to four months longer than the usual period of training, are summarized in Figs. 8 and 9. Seven hundred and seventy-eight (45.7 per cent) of these men were selected for treatment because the nasopharyngoscopic examination disclosed hyperplastic lymphoid tissue in and around the pharyngeal orifice of the eustachian tubes. The rate of aerotitis before treatment, if known, would be the best basis for determination of the effect of therapy. Instead it became necessary to use as controls, not the men with hyperplastic lymphoid tissue, but men with a normal looking nasopharynx. Living and flying conditions were the same for both.

Since the period of observation covered both winter and spring, a seasonal variation would be expected and is apparent in the control group, in whom the rate dropped from .45 per 100 flights to .16 for flights at high altitudes (Fig. 8). The incidence of aerotitis in the men under treatment during the winter was .96 per 100 flights at high altitude or more than twice that in the control group. For the period after treatments were completed, the rates in the treated and untreated men were almost the same, .17 and .16 per 100 flights respectively. Part of the drop in each group may have been due to seasonal conditions, but the value of the therapy is shown by the fact that the final rate in the treated group is almost identical with that of the control group.

In the men who failed to show improvement after completing their irradiation treatments, examination of the nasopharynx practically always revealed lymphoid tissue still present, either as enormous masses in the midline or as nodules about the pharyngeal orifice of the eustachian tube. In those with the huge adenoidal growth it was felt that an adenoidectomy plus irradiation would have been more desirable. In those with nodules of lymphoid tissue apparently resistant to irradiation, an additional treatment was indicated. This was well shown in 20 men who developed aerotitis more than 25 days after the third treatment, all of whom required an additional treatment or two. Only two men developed aerotitis after the fourth treatment and in both of these another treatment was indicated.

The following case reports are presented to illustrate the effects of irradiation therapy.

REPORT OF CASES

CASE 1.—1st Lt. M. J. S., Bombardier, B-24, age 26. Total flying time 650 hours, 200 of which were at altitudes above 16,000 feet. First seen on January 30, 1945.

History. This man gave a history of two colds a year which last from 7 to 10 days, and he had had a tonsillectomy and adenoidectomy. He was grounded once for five days with acute aerotitis. Another time his left ear blocked for 12 hours after altitude chamber test.

Examination. There were slit-like eustachian orifices with heavy masses of hyperplastic lymphoid tissue on the torus tubarius and in the fossa of Rosenmüller; also a moderate mass of lymphoid tissue in the midline.

Progress. He received three radium treatments, the last one on March 26, 1945. At this time he stated that he had had no ear difficulties at all and felt that the treatments had helped him a lot. There was moderate reduction in the amount of lymphoid tissue. He was reexamined on June 9, 1945, when he stated that his treatments had helped him clear his ears "very much" easier. His eustachian tube orifices were so clear of lymphoid tissue at this time that no additional irradiation was given.

CASE 2.—Cpl. C. H. D., Engineer, B-24, age 19. Total flying time 90 hours, 15 of which were at altitudes above 16,000 feet. First seen on February 20, 1945.

History. This man gave a history of eight long head colds a year. His ears had blocked two or three times in flight, and he could not go higher than 5,000 feet in the altitude chamber because of ear block. His last altitude chamber test had been three days before his first examination.

Examination. At that time his right ear drum showed hemorrhagic areas. His tonsils were present and his lateral and posterior pharyngeal walls had areas of red lymphoid tissue. In his nasopharynx the tubal orifices and the fossa of Rosenmüller were hidden by an enormous amount of lymphoid tissue which practically filled the entire nasopharynx.

Progress. He received four radium treatments. At the time of the third treatment he stated that his ears no longer blocked up but that they cleared a lot easier than before. At this time there were

fairly clear tubal openings but a large mass of midline adenoidal tissue remained. At the time of the fourth treatment, on June 8, 1945, his nasopharynx was still further improved, although the large central mass remained. He stated that his "ears clear much easier—used to stay blocked for three or four hours after every flight, but not now."

CASE 3.—1st Lt. D. L. S., Pilot, B-24, age 23. Total flying time of 2200 hours of which only 20 were above 16,000 feet. First seen on February 20, 1945.

History. This man gave a history of three colds a year which might last from one to eight weeks. His ears blocked up frequently after flying and remained blocked for hours or days. He was grounded twice for aerotitis, several days each time. At one time he had a frontal sinus pain lasting one week after a flight.

Examinations. The tonsils were present; the pharynx, innocent. The tubal orifices were thickened, edematous and compressed. The fossa of Rosenmüller was filled with lymphoid tissue and there was a moderate amount of lymphoid tissue in the midline of the nasopharynx.

Progress. The patient received three irradiation treatments. Thirty days after the third treatment he was re-examined but his nasopharynx and tubal orifices were clear of lymphoid tissue and no additional therapy was indicated. He stated that his ears blocked frequently during his early training here, but that during the latter part of his training his ears gave him no trouble and cleared much easier. He had not been grounded during his stay at this station.

CASE 4.—Cpl. L. W. N., Radio-operator, B-24, age 26. Total flying time of 350 hours, 30 of which were at altitudes above 16,000 feet. First seen September 12, 1944.

History. He had four or more colds a year lasting from 3 to 4 weeks each. He had had a submucous reaction and twice had had a tonsillectomy. There was no history of aerotitis but his ears had been plugged for five days after an altitude chamber flight.

Examination. Both drums were retracted. Both tonsils were removed but he had large masses of lymphoid tissue on his posterior and lateral pharyngeal walls. In his nasopharynx there was a large central nodular mass of adenoids. Both fossae of Rosenmüller were filled with lymphoid tissue and his eustachian tube orifices were slits, being obscured by lymphoid tissue.

Progress. He was given a radium treatment on September 9, 1944, and again on November 1, 1944. At this latter date he stated that his ears had blocked many times before ever taking treatments and had also blocked up three times in the last ten days. He had an acute bilateral aerotitis at this time with an acute cold.

On December 20, 1944, he was seen in Foggia, Italy by the M.T.O. Irradiation Team. He now had 450 (approximately) total flying hours, 100 of which were at high altitudes. He gave a history of over 15 previous aerotitis attacks with a total of 11 days of being grounded. He was given a third radium treatment at this time and felt that he had been helped somewhat. On January 20, 1945, he again had a bilateral aerotitis after a high altitude flight and was given a fourth radium treatment. He admitted that his ears blocked up three times after the last three flights. He stated that although his attacks continued he felt they were of much shorter duration. Examination at this time showed no evidence of improvement in the condition of his nasopharynx. In this patient, surgical removal of the main mass of adenoids supplemented by irradiation would have been better treatment.

DISCUSSION

The basic factor underlying the production of aerotitis is the necessity for the subject to undergo a change in barometric pressure. The degree of change necessary varies with the individual and is directly related to the ventilating ability of his eustachian tubes. In airmen the need for adjustment to this change is during descent from flight level to ground level. It is during this phase of the flight that aerotitis occurs. An entirely similar syndrome of blocked ear occurs in submarine personnel, deep-sea divers and caisson workers. The mechanism of the production of the blocked ear is the same, except that fliers descend from rare to normal atmospheric pressure, whereas these men descend from normal to even denser atmospheric pressure. Failure to ventilate the middle ear during this phase results in a blocked ear similar in all respects to the aerotitis encountered in flying personnel.

The exact role that lymphoid hyperplasia in the region of the tubal orifice plays in the production of aerotitis is not completely understood. It is a commonly held misconception among many physicians that lymphoid hyperplasia is a relatively rare finding in the nasopharynx of adults. It is the experience of the authors as well as of other investigators that lymphoid hyperplasia occurs very fre-

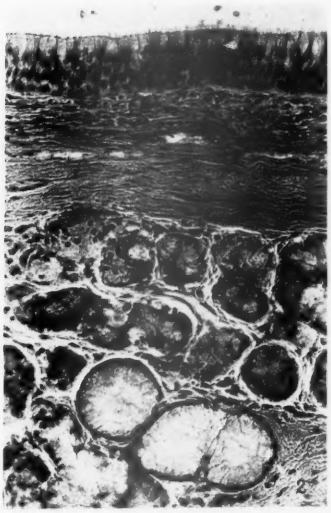

Fig. 10.—Photomicrograph showing details of structures of the medial wall of the cartilaginous part of the eustachian tube in its middle third, exclusive of the cartilage and its perichondrium. x185. At this magnification the cilia and the goblet cells of the columnar epithelium show clearly. Immediately beneath the basement membrane of the epithelium and separating it from the dense fibrous layer of the mucosa is a zone of looser tissue that contains diffuse lymphoid tissue. True lymphoid nodules, with germinal centers, occur but rarely in the tubal mucosa, but diffuse lymphoid tissue is usually present throughout its length. The mixed character, mucous and serous, of the glandular acini is easily seen at this magnification. The secretion from these glands passes through numerous small ducts, not seen in this section, to the lumen of the tube, where it mingles with the mucus from the goblet cells.

quently in adults, a fact which can readily be confirmed by routine examination of the nasopharynx with a nasopharyngoscope.

The high incidence of hypertrophied tissue in subjects who develop aerotitis leads one to presume that a faulty or inadequate ventilation of the middle ear is the cause. It is the opinion of the authors that hyperplastic lymphoid tissue is related to the production of aerotitis by one or more of the following mechanisms:

Mechanical Obstruction. This may be due to:

1. Hyperplastic lymphoid tissue in the fossa of Rosenmüller and in and around the orifice of the tube (Fig. 7*b*, 7*c*);

2. A nodule of lymphoid tissue extending into the lumen of the ostium (Fig. *7d*);

3. Edema of the mucous membrane at the pharyngeal orifice. The infection that gives rise to the edema also causes hyperactivity of the abundant mucous glands in this region which impairs the patency of the tube.

Acute Infection. Infection is the commonest cause of lymphoid hyperplasia. It has been observed repeatedly with the nasopharyngoscope that small nodules of lymphoid tissue in the fossa of Rosenmüller, which look harmless and lead to classification of the nasopharynx as normal, may become so large following an acute nasopharyngitis as to change the whole appearance of the nasopharynx and to be directly responsible for ear symptoms such as impaired hearing, otitis media, or aerotitis. The tubal mucosa itself contains nodular lymphoid tissue only in patients with chronic otitis media, and only in a few of them, but diffuse lymphoid tissue is normally present (Fig. 10) throughout the length of the tube.

In other words, a true tubal tonsil, such as is described in many texts, does not exist. This statement is based on study of the sections of the human ear in the collection of the Otological Laboratory of the Johns Hopkins University. This diffuse lymphoid tissue may, however, if inflamed, cause actual narrowing of the lumen. The combined effect of the resultant edema and hypersecretion of mucus by the tubal glands increases the difficulty of ventilating the middle ear.

Chronic Infection. Small masses of lymphoid tissue in the fossa of Rosenmüller and on the torus tubarius itself may harbor infection and maintain the contiguous tissues in a constant state of inflammation. The presence of an infected mass of lymphoid tissue predisposes the patient to acute upper respiratory infections with the sequence of events described above.

Other Factors Related to the Production of Aerotitis. Armstrong and Heim[2] describe a flutter-valve-like action of the eustachian tube during descent, which closes off the tube when no voluntary attempt is made to ventilate the middle ear. This is due to failure of the instructors to emphasize the necessity of ventilating the ears on descent and to teach effective methods. Other causes include inattention, being asleep, or in hospital planes the effect of analgesics.

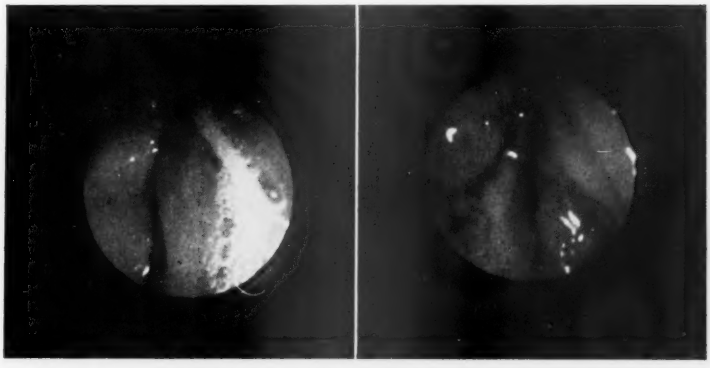

Fig. 11.—A stream of mucopurulent discharge from an infected sinus flows over the edematous torus and into the fossa of Rosemuüller.

Fig. 12.—Abnormally elongated posterior tip of right inferior turbinate (upper left of picture). The orifice of the eustachian tube is in the lower central portion of the picture and lymphoid tissue (upper right) fills the fossa of Rosemüller.

Infections from Sinuses. Purulent discharge from infected sinuses may bathe the orifice of the eustachian tube and maintain a state of subacute inflammation and edema of the ostium (Fig. 11).

Edema due to an Allergic State. Subjects have been observed who have eustachian tube obstruction during the period of allergic edema, but upon subsidence of the reaction have normal appearing ostia.

Stenosis, Complete or Incomplete, Secondary to Surgical Procedures in the Nasopharynx. The existence of this condition is rare. In over 3,500 subjects examined with a nasopharyngoscope no case of stenosis was observed.

Absorption of Oxygen from the Middle Ear after Descent. Behnke and Willmon[4] described a delayed aerotitis appearing about 18 hours after prolonged inhalation of oxygen at high altitudes. They explained this phenomenon as due to a negative pressure effect brought about by the absorption of oxygen from the middle ear spaces during sleep when voluntary opening of the auditory tube is not effected.

Closure due to Mandibular Joint Malfunction. Costen[5] observed ear symptoms and mandibular imbalance following molar extractions in patients for whom no suitable denture was made. He regarded the tubal symptoms as due to abnormal excursion of the condyle and relaxation of the internal pterygoid muscles. By dental measures Willhelmy[6] was able to relieve ear pain and dizziness on descent in six pilots.

Hypertrophied Turbinate. Three patients in this clinic showed such marked hypertrophy and elongation of the inferior turbinate that the posterior tip almost touched the tubal orifice. Slight additional swelling could conceivably obstruct the tube opening (Fig. 12).

SUMMARY AND CONCLUSIONS

1. Examination of the nasopharynx with a nasopharyngoscope disclosed that hyperplastic lymphoid tissue about the eustachian tube orifice was present in 44.3 per cent of 3,525 airmen seen in this clinic.

2. The use of radium in a nasopharyngeal applicator is a safe, practical, and effective method of reducing hyperplastic lymphoid tissue about the orifices of the eustachian tubes.

3. Objective improvement, that is, reduction of the amount of hyperplastic lymphoid tissue in or about the eustachian tubes, occurred in approximately 90 per cent of all who were re-examined 30 days after receiving the third treatment.

4. Subjective improvement occurred in 54 per cent of fliers who were treated with radium because of hyperplastic lymphoid tissue in or about the eustachian tubes and who had previously had aerotitis.

5. Irradiation therapy of hyperplastic lymphoid tissue about the eustachian tube orifice was effective in the prophylaxis of aerotitis. In a study of 778 men with hyperplastic lymphoid tissue, it was found that aerotitis after high altitude flights occurred twice as frequently as in a control group of 922 men with eustachian tube orifices clear of lymphoid tissue. After completion of treatments the incidence of aerotitis in the treated men became practically identical with that of the control group.

Acknowledgement to Sgt. William Sednek, Pvt. Jessie Barra, and Miss Cora Gentile is made for their loyalty and valuable assistance in the management of this clinic during the year 1944-1945.

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LIV

REPORT OF 52 CASES OF RECURRENT AEROTITIS; FIRST AIR FORCE, MITCHEL FIELD, NEW YORK

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AND

MAJOR PAUL L. MAGNUSON

MEDICAL CORPS, ARMY OF THE UNITED STATES

The following report is based on a group of patients who either reported or were ordered to report because of recurrent aerotitis. Subjective improvement was judged upon the basis of flight reports of the individuals and the results obtained in altitude chamber flights. No judgment was made on the basis of a single altitude chamber flight alone. Objective improvement was determined with the nasopharyngoscope 30 days after the third treatment. These men were engaged in flying many different types of aircraft and were both returnees from combat and permanent party flying training personnel. Each patient had the routine history and work-up and such special procedures as were indicated. In 25 cases an altitude chamber run was accomplished at the time of the post-treatment checkup. Inasmuch as the history of aerotitis was definite, an altitude chamber run was not made at the time of the first examination because it was felt that the risk of precipitating another attack just before starting the radium treatments was inadvisable.

Treaments were given at 25-day intervals and the living conditions were such as are encountered in the various training centers in this country. No difficulty such as that experienced in the field was encountered since most of this group were permanent party personnel. Almost all of the patients were interested in either returning to flying or getting rid of the troublesome symptoms encountered on their flights.

Of the 52 men treated in this study, 44 reported definite subjective improvement after treatment was completed. Two of these men were test pilots in P-47 (Thunderbolt) type of aircraft and had developed recurrent aerotitis. After treatment these men were able to descend at rates in excess of 6,000 feet per minute without difficulty in ventilating their ears.

The altitude chamber runs were arbitrarily limited to 20,000 feet and the initial rate of descent was 500 feet per minute. This rate of descent was increased gradually, depending upon the tolerance of the individual involved. The maximum rate of descent was 6,000 feet plus, per minute. This figure of 6,000 feet was the maximum capacity of the manometer and it is believed that a rate of 8,000 feet per minute was actually reached. Twenty-five of the 52 men were given chamber flights after completion of treatments. Three of the 25 men developed aerotitis and were considered not to have been benefited. The remaining 22 men successfully completed this test without ear-ventilating difficulties.

An analysis of failures in this group of 52 cases does not reveal any single predisposing factor which is common to all. The total number of failures in 52 cases was eight. Only two of these men showed no objective reduction in lymphoid mass. The various factors probably causing failure were:

Case 1—Allergy; chronic ethmoiditis.

Case 2—Frequent colds; operational fatigue, severe, requiring hospitalization.

Case 3—Chronic maxillary sinusitis, right.

Case 4—Seasonal allergy.

Case 5—Ethmoiditis; traumatic rupture of tympanic membrane due to aerotitis.

Case 6—Vasomotor rhinitis.

Case 7—Vasomotor rhinitis and ethmoiditis.

Case 8—Frequent colds.

No untoward reactions of any type were observed.

The success of irradiation therapy in these men, most of whom had a long history of aerotitis, is particularly convincing of the value of this method of treatment.

LV

REPORT OF THE THIRD AIR FORCE IRRADIATION UNIT, 31 AUGUST 1945

CAPTAIN JEROME J. GLAUBER
MAJOR JOHN W. SMITH
MEDICAL CORPS, ARMY OF THE UNITED STATES
AND
LT. COLONEL DONALD H. EARL
UNITED STATES ARMY

The Third Air Force Irradiation Unit was established by Third Air Force letter 25-1 as an operational component to accomplish an aerotitis control program. The mission of the program was to conserve flying personnel, reduce hospitalization and thereby reduce the noneffective rate caused by aerotitis. The unit operated from an Irradiation Clinic established at Drew Field, Florida, which was directly under the control of Headquarters, Third Air Force, for all policy and procedure. The clinic was well equipped with all facilities necessary to conduct thorough examinations and treatment. The three medical officers, otolaryngologists who had received special indoctrination in the use of nasopharyngeal radium applicators in courses conducted by Dr. Samuel J. Crowe of the Johns Hopkins University, under the auspices of the Air Surgeon, were the only ones in the Third Air Force who conducted the examinations and treatments. To assist them one nurse and two enlisted men were assigned to the unit.

Although the advantages of screening the entire flying personnel of the Third Air Force were apparent to us, it was impossible for our small staff to accomplish this task, since the personnel of the Third Air Force is stationed at many widely separated bases.

Screening was further made impracticable because there were but two sets of radium applicators available. It was therefore decided to treat only those men who actually had had aerotitis, or had experienced difficulty in clearing their ears during aerial flight or low pressure chamber runs. Our results may differ from those in other Air Forces, because all of our cases are classified under therapeutic headings and none under prophylactic classifications. The original selection of cases was accomplished by the Flight Surgeons at Third

Air Force bases, who were instructed to review their "Care of Flyer Report" for the past months and screen all flying personnel under their care for presence of, or history of, aerotitis.

The following method was established to accomplish the mission:

a. Bases within a short radius of Drew Field (approximately 200 miles) were given appointment dates on which to send their cases to headquarters clinic.

b. Monthly air trips were scheduled to major bases centrally located throughout the Third Air Force during the first week of each month. All smaller bases in each of the selected areas were advised of the schedule and requested to send their cases to the selected base in their area on the appointed date. By this method irradiation therapy was made available to all flying personnel in the entire Third Air Force at monthly intervals.

c. All trips were made in an Army Air Force transport plane, C-47 type. Either two or three of the medical officers, one nurse, and two enlisted men made each trip. Entire Irradiation Clinic facilities were carried on the plane, including examination, treatment and recording material. Constant follow-up records and communications were made in locating and contacting individual personnel as they transferred to various bases within the Third Air Force during the course of their treatment. This constituted a major problem, but the Flight Surgeons at all bases cooperated very well in this task, with the result that many men were given each of their treatments at a different base, as they progressed in their combat crew training.

All treatments were limited to six minutes and forty seconds each until 13 March 1945, after which the time was extended to eight minutes and thirty seconds, following the receipt of a personal communication from Dr. S. J. Crowe.

In summary, the actual irradiation work performed by 31 August 1945 is as follows:

1. A total number of 1177 flying personnel were treated. This includes patients started and completed by our unit, patients started by our unit but transferred to other Air Forces before their course of therapy was completed, and those whose treatments were initiated by other Air Force irradiation units but completed by our unit. The last group includes a large

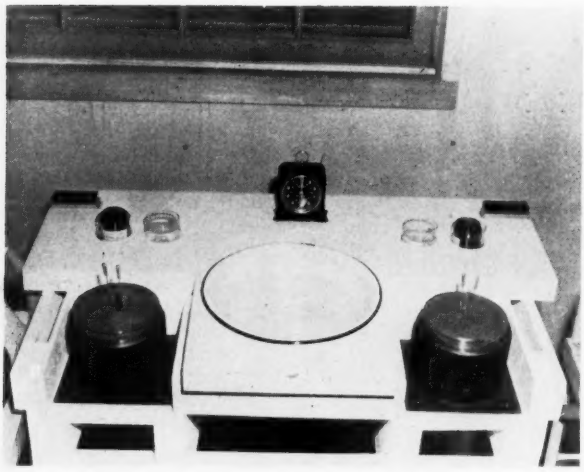

Fig. 1.—Illustration of the radium treatment table used in the Third Air Force Irradiation Clinic.

number of returnees from the European and Mediteranean Theaters.

2. A grand total of 2289 irradiation treatments were given to flying personnel since the clinic was established.

3. In recording the results, our report will be limited strictly to the first group mentioned above, i.e., those patients whose entire course of therapy was administered by our clinic. The total number in this group is 381. It is necessary for purposes of accuracy to confine our report to this group, because we have no record of initial nasopharyngeal findings in patients begun in other clinics and completed by us. Similarly the other Air Force clinics will be unable to completely evaluate results in those patients who were transferred to them before their therapy was completed by us.

All patients received nasopharyngeal examinations before the first treatment. At the time of the second treatment, no examination was made, but a query of subjective results was made and recorded. When the patient reported for the third treatment, another nasopharyngeal examination was made to determine objective changes,

and also a history of subjective results was recorded. Most patients were then given a third treatment and the therapy considered completed if objective findings and history showed improvement. Those who were not sufficiently improved by the time of the third treatment were asked to return for examination and a possible fourth treatment. None was given more than four treatments.

Both subjective and objective evaluation of results of therapy was made, using history, direct inspection of the nasopharynx and tympanic membranes, and the low pressure chamber when possible.

Subjective improvement was credited only when the individual stated that the ears could be cleared more easily, or that there was an absence of pain in ears on rapid descent and an absence of "stopped-up ears" for prolonged periods after flight, when previous to treatment one or all of the above complaints were present. Use of the low pressure chamber was found to be especially valuable in testing results. Objective improvement was credited when direct inspection of the nasopharynx revealed appreciable reduction of lymphoid tissue on the torus, within the orifice of the eustachian tube, in the fossa of Rosenmüller, or on the posterior nasopharyngeal wall. In this regard the sketch, made of the nasopharynx at the time of the first examination, was invaluable. Another indication of objective improvement was the absence of objective findings of aerotitis on otoscopic examination after comparable aerial flights or low pressure chamber runs which previously had produced aerotitis.

Using these criteria, our results, based on 381 completed cases, are reported as follows:

> Subsequent to the first treatment (at the time of the second treatment) 54.4 per cent of the patients signified that they were improved subjectively. Following the second treatment (recorded at the time of the third treatment) 90.5 per cent were subjectively improved, and 95.2 per cent showed objective improvement.
>
> It is noted that our final results are recorded as prior to the final treatment. It is unfortunate that our followups do not include examination a month or more subsequent to the final treatment. This would most likely increase the number of final improvements.

The following table comprises the 28 cases in whom the desired results were not obtained.

ANALYSIS OF FAILURES

CASE NO.	ABNORMAL FACTORS	NUMBER OF TREATMENTS	IMPROVED OBJECTIVE	IMPROVED SUBJECTIVE
1	Grossly enlarged tonsils and adenoids	3	No	Yes
2	Scarring of tissue medial to and including torus tubaris (following T and A.)	3	Yes	No
3	No reason; lateral bands present.	3	Yes	No
4	Recurrent old right otitis media; retracted Shrapnell's and pars tensa, right.	4	Yes	No
5	4 colds (10 days each) per year; grossly enlarged tonsils and adenoids; lateral bands present.	4	Yes	No
6	Purulent right pansinusitis, subacute	4	Yes	No
7	Ruptured left drum twice in past 2 years (After Treatment torus still boggy).	3	Yes	Slight
8	4 colds (3-4 weeks each) per year; left ear lanced in childhood.	3	Yes	No
9	No reason; lateral bands and granular pharynx present.	4	Yes	No
10	Otitis media 1928; lateral bands present; grossly enlarged adenoids; lymphoid tissue on left torus.	3	No	No
11	Aerosinusitis; grossly enlarged adenoids.	4	No	No
12	Narrow right eustachian tube; cautery nasal turbinates; aerosinusitis.	3	Yes	No
13	Constant colds; grossly enlarged adenoids.	4	No	No
14	Constant colds; scarred drums; complains of sinus pains.	4	No	Slight
15	Aerosinusitis; left drum scarred.	3	Yes	No
16	Grossly enlarged adenoids.	3	No	Yes
17	Frequent colds; vasomotor rhinitis; hyperemia of middle ear; boggy and pale posterior tips of turbinates; grossly enlarged tonsils and adenoids.	3	No	No
18	Bilateral otitis media, childhood; aerosinusitis; grossly enlarged tonsils and adenoids.	3	Yes	No

ANALYSIS OF FAILURES—(*Continued*)

CASE NO.	ABNORMAL FACTORS	NUMBER OF TREATMENTS	IMPROVED OBJECTIVE	IMPROVED SUBJECTIVE
19	Chronic colds; scarred drums; grossly enlarged tonsils and adenoids.	3	Yes	No
20	Vasomotor rhinitis; left nasal obstruction.	3	No	No
21	Otitis media, childhood; scarring, retraction, hyperemia and fluid in middle ears.	3	Yes	No
22	Nasal septal deviation.	3	Yes	No
23	Frequent colds; grossly enlarged tonsils and adenoids; lateral bands present.	3	Yes	No
24	Chronic colds; septal deviation; vasomotor rhinitis; grossly enlarged adenoids.	3	Yes	No
25	Scarring of drums; grossly enlarged tonsils and adenoids.	3	No	No
26	Chronic colds.	4	Yes	No
27	Chronic colds; drums retracted, hyperemia of middle ear; grossly enlarged tonsils and adenoids.	3	Yes	No
28	Fear of flying (psychic)	2	Yes	No

It will be noted above that many cases have more than one abnormal finding. Summarizing the above chart, the following reasons or combinations of causes for failure to obtain good results occurred in this order of frequency.

History of frequent colds.	10 cases
Grossly enlarged tonsils and adenoids.	8 cases
Grossly enlarged adenoids alone.	5 cases
Scarred tympanic membrane.	5 cases
Recent or old otitis media.	5 cases
Nasal obstruction.	4 cases
Aerosinusitis.	4 cases
Hyperemia or fluid in middle ear.	3 cases
Vasomotor rhinitis.	3 cases
Purulent sinusitis.	2 cases
Perforations of tympanum.	2 cases
No reason at all found.	2 cases
Narrowing of mouth of eustachian tube.	1 case
Scar contracting nasopharyngeal wall and tubarius.	1 case
Massive amount of lymphoid tissue on torus tubarius.	1 case
Fear of flying (psychic).	1 case

Attempts were made in all cases of hypertrophy of adenoids to have adenoidectomies performed, but, for administrative and other reasons, adenoidectomies were not performed in the above cases.

An analysis of the failures allows the following observations to be made:

a. Grossly hypertrophied adenoids, usually obstructive in size, constitute the most frequent cause for poor results. These cases also seemed to show much more lymphoid tissue in the region of the eustachian orifice in addition to the central mass. It is interesting to note that other cases with similar findings received maximum benefits from irradiation after adenoidectomy was performed. This gives an added incentive to recommend adenoidectomy before irradiation in obstructive cases.

b. History of frequent colds and chronic nasopharyngitis occurred quite frequently in the list of failures. In these cases, the problem is usually individual. A search should be made for foci of infection, and if none is found, the use of a chemotherapeutic agent may be considered.

c. Permanent defects either in the tympanic membranes or in the nose are next in frequency. Intranasal surgery offers relief for the cases due to nasal obstruction, but those having structural defects in the ear itself are not as easily corrected.

It is our experience, however, that the above three classes of individuals definitely do not constitute a contraindication to irradiation therapy. On the contrary, we have treated a very large number of patients, as described above, who received excellent results, both subjectively and objectively. This is especially true in the second group, many patients having observed a noticeable decrease in the incidence and severity of colds.

d. The degree of objective improvement does not insure a similar subjective response. In this regard, particular care was taken that "lack of incentive to fly" cases were carefully screened by a neuropsychiatrist before acceptance for irradiation treatment. We attempted to reserve the use of the radium for those who "wanted" to be helped. Psychologically, it would have been poor medical practice intentionally to use the radium applicators on anyone who did not desire a good result. In fact, one can readily imagine such an individual claiming to be made worse by treatments. At any rate, it would afford the individual an easy method for malingering.

In addition to the 1177 flying personnel treated, 91 non-flying army personnel were given 166 treatments, and 39 civilian dependents were given 79 treatments. These cases were obtained from various Ear, Nose and Throat Clinic surgeons, who desired irradiation therapy for their regular patients, which patients were treated at their request. At no time did this interfere with or delay the treatment of flying personnel. Among the various reasons for therapy in these cases were obstructive deafness, catarrhal otitis media, persistent purulent otitis media, recurrent nasopharyngitis. Several children whose previous adenoidectomies were unsatisfactory or who had various degrees of defective hearing were also treated. The variety of the above conditions treated does not allow a critical summary analysis, but in general the results were most encouraging.

Throughout the course of the entire program we were fortunate in having the excellent assistance of the same two enlisted men, Sergeant Arthur B. Lincoln, Jr., and Corporal Walter S. Kozaczka.

DREW FIELD, TAMPA, FLORIDA.

LVI

AEROTITIS AND RADUIM THERAPY IN THE EIGHTH AIR FORCE

Major Braswell E. Collins

Major John W. Eschenbrenner, Jr.

and

Captain Phillip L. Lyle

Army of the United States

1 PURPOSE.

a. To conduct a study of aerotitis in flying personnel of the Eighth Air Force. This included heavy bombardment crews and fighter escort pilots.

b. To give radium therapy to the eustachian orifices in the men having repeated attacks of aerotitis and showing lymphoid hyperplasia in the region of eustachian orifices.

c. To evaluate the results of radium treatment.

2. METHOD.

a. General Plan. The three medical officers were assigned to the three Air Divisions of the Eighth Air Force, one to each division, Major John W. Eschenbrenner, Jr., to the First, Major Braswell E. Collins to the Second, and Captain Phillip L. Lyle to the Third.

The plan was for the three officers to work in the field at separate divisions, examining the patients and giving the radium therapy at the dispensaries on the bases. In this manner conditions could be better studied, closer contact with the Flight Surgeons maintained and the flying personnel not required to leave their bases. In instances in which the flying personnel were away from the bases on tactical missions the medical officer saw them on their return.

An initial tour of the bases was made by the medical officers individually to acquaint the Group and Squadron Flight Surgeons with the program so that they might select personnel with aerotitis for examination and possible treatment with radium.

Those examined were flying personnel who were in the acute stages of aerotitis or those who had had previous attacks. For com-

pleteness of the study, reference was made to the Care of Flyer records, 52-A's and dispensary records. In addition, a list of men who had been given radium therapy to the eustachian orifices at a U. S. Army Station Hospital and at a U. S. Army General Hospital was secured and those that were still present on the bases were seen and the therapy in most instances was continued.

A tour of all bases in each Air Division was made once a month. Equipment necessary for examinations and for radium treatments was carried from base to base.

Travel from base to base was done by any means obtainable. Jeeps, ambulances, reconnaissance cars, trucks, mail carriers and airplanes were used. The radium applicators in the lead container weighing 94 pounds were carefully guarded to prevent loss or damage and constant care was exercised during treatments to prevent unnecessary exposure of personnel to the radium.

After each monthly tour of the bases, conferences were held and the program was discussed with the Surgeon of the Eighth Air Force.

The examinations, treatments, and observations were done at the air bases from 1 November 1944 to 14 February 1945. Following that period, two of the medical officers were placed on further duty with station hospitals serving the air bases. Cases of aerotitis were referred to them at these hospitals. In some instances in which the men failed to report to the hospital, the medical officers went to the air bases for follow-up. The third medical officer continued to work on a mobile basis. The study was terminated 1 June 1945.

b. History of Cases. On each case of aerotitis the medical officer took a careful history and recorded it on a form devised for this purpose.

c. Examination of Cases. A careful ear, nose and throat examination, including examination with the nasopharyngoscope, was made on each patient when first seen, and if chosen for treatment, he was re-examined prior to each treatment.

d. Indications for Treatment. Men selected for treatment were those having both a history of repeated attacks of aerotitis and hyperplastic lymphoid tissue about the eustachian orifices.

e. Treatment. The technique of treatment is given in the introductory portion of this paper. In the cases treated in the Eighth

Air Force the applicators were left in place for six minutes and forty seconds at each treatment.

f. Controls. On one third of the bases visited the men were examined but radium therapy not started when indicated, these bases being used as controls. The same criteria were used for the selection of controls as for the selection of cases to be treated.

g. Nomenclature. In this paper cases not fulfilling the criteria for treatment are referred to as "untreated" cases. Those given radium therapy are referred to as "treated" cases. Those cases fulfilling the requirements for treatment but the treatment not given (the cases being used as controls) are referred to as "controls."

For completeness of the study the men were classified according to the number of attacks of aerotitis requiring grounding, the amount of lymphoid hyperplasia present about the eustachian orifices, and the amount of subjective improvement following radium therapy.

In reference to grading according to number of attacks, cases in which the flier had attacks only one of which required grounding were called "mild." Those cases in which the flier was grounded from two to five times inclusive were considered "moderately severe" and those in which the flier was grounded more than five times were considered "severe."

The amount of lymphoid hyperplasia about the eustachian orifices was graded as no lymphoid hyperplasia, one, two, or three plus lymphoid hyperplasia.

3. DATA ON AEROTITIS CASES EXAMINED.

a. During the study a total of 1,124 men with aerotitis were examined. Of these, 977 were bomber personnel and 147 were fighter pilots. Although the primary purpose was to treat the indicated cases with radium and to evaluate results of the treatment, the study gave opportunity for other observations on aerotitis as found under combat conditions.

Many Flight Surgeons felt that early return to altitude followed by a slow descent was not injurious to an acute aerotitis and in some instances actually seemed to hasten recovery.

Flying personnel consistently were well acquainted with the methods of ventilating the middle ears during changes in altitude.

b. The following table shows the distribution according to severity of cases in the untreated, treated and control groups:

	UNTREATED CASES	TREATED CASES	CONTROL CASES
Mild	512	189	28
Moderately severe	135	175	35
Severe	7	40	3
Total	654	404	66

c. The correlation between difficulty in ventilating the ears in the decompression chamber and the later development of aerotitis in high altitude flying is shown in the following table:

	TOTAL CASES SEEN	CASES WITH HISTORY OF TROUBLE IN CHAMBER	PERCENT
Mild	729	161	22.1
Moderately severe	345	128	37.1
Severe	50	30	60.0
Total	1124	319	28.4

d. The correlation between difficulty in ventilating the ears in the decompression chamber and the later need for radium treatment is shown in the following table:

NUMBER OF PATIENTS GIVING HISTORY OF DIFFICULTY IN THE DECOMPRESSION CHAMBER

Untreated group 124 or 19.0 per cent of the untreated group,
Treated group 168 or 41.6 per cent of the treated group,
Control group 27 or 40.8 per cent of the control group.

e. The correlation between the history of groundings previously in the United States and the later need for radium treatment is shown in the following table:

NUMBER OF PATIENTS GIVING HISTORY OF PREVIOUS GROUNDINGS FOR AEROTITIS IN THE UNITED STATES:

Untreated group 155 or 23.6 per cent of the untreated group,
Treated group 142 or 35.1 per cent of the treated group,
Control group 26 or 39.4 per cent of the control group.

f. Reference to the above three tables shows that those men grounded for aerotitis in the United States and those having difficulty in ventilating the ears in the decompression chamber should be thoroughly investigated to see if radium therapy is indicated.

g. In reference to head colds in England, it was a common occurrence, particularly in the winter for American personnel, to have a continuous mild nasal congestion with mucous discharge. This in flying personnel returning from a mission was often accompanied by a subclinical ear involvement, consisting of a mild injection and sometimes slight retraction of the tympanic membrane, which was not considered a contraindication to flying.

Superimposed on the above, flying personnel frequently developed an acute head cold. The men studied were questioned as to whether they considered their attacks of acute aerotitis were associated with an acute head cold. Their response was as follows:

	UNTREATED	TREATED	CONTROLS	TOTAL
Head colds during attacks	465 (71.3%)	220 (54.5%)	33 (50.0%)	718 (64.0%)

There was a question as to whether acute aerotitis was more frequently associated with an acute head cold in those with lymphoid hyperplasia compared to those without lymphoid hyperplasia. These data are tabulated:

Total number of patients with aerotitis seen	1124
Number having lymphoid hyperplasia around eustachian orifices	805 or 71.6%
Number of these having head colds with attacks of aerotitis	495 or 61.5%
Number having no lymphoid hyperplasia around eustachian orifices	319 or 28.4%
Number of these having head colds with attacks of aerotitis	223 or 70.0%

h. The incidence of lymphoid hyperplasia in the personnel observed is tabulated:

	UNTREATED	TREATED	CONTROLS	TOTAL
Total cases	654	404	66	1124
No lymphoid hyperplasia at eustachian orifices	319 (48.8%)	0	0	319 (28.4%)
One plus lymphoid hyperplasia at eustachian orifice	210 (32.1%)	172 (42.6%)	23 (34.9%)	405 (36.0%)
Two plus lymphoid hyperplasia at eustachian orifice	59 (9.0%)	118 (29.2%)	15 (22.7%)	192 (17.1%)

	UNTREATED	TREATED	CONTROLS	TOTAL
Three plus lymphoid hyperplasia at eustachian orifice	66 (9.1%)	114 (28.2%)	28 (42.3%)	208 (18.5%)
Lymphoid hyperplasia in oropharynx (path. tonsils, lateral bands, follicles)	198 (30.3%)	194 (48.0%)	26 (39.4%)	418 (37.1%)

Correlation of the amount of lymphoid hyperplasia about the eustachian orifices and previous history of groundings for aerotitis is tabulated:

LYMPHOID HYPERPLASIA

	NONE	ONE PLUS	TWO PLUS	THREE PLUS	TOTAL
Mild	256 (35.1%)	243 (33.3%)	116 (15.9%)	114 (15.6%)	729
Moderately severe	60 (17.4%)	146 (42.3%)	58 (16.8%)	81 (23.4%)	345
Severe	3 (6.0%)	16 (32.0%)	18 (36.0%)	13 (26.0%)	50
Total	319 (28.4%)	405 (35.9%)	192 (17.1%)	208 (18.5%)	1124

Reference to the above table shows that of those fliers having few attacks of acute aerotitis, few of which required grounding, a large percentage had little lymphoid hyperplasia, whereas of those having a greater number of attacks of acute aerotitis, requiring groundings, a large percentage had considerable lymphoid hyperplasia.

4. DATA ON PATIENTS GIVEN RADIUM THERAPY.

a. The following table shows the improvement 30 days after one treatment with radium in reference to the previous number of groundings and the amount of lymphoid hyperplasia:

Number given one radium treatment	404	
Number followed up 30 days later	349	(86.5%)
Number without sufficient flying	31	
Number with sufficient flying for evaluation (tabulated)	318	

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD Improved	MILD Not Imp.	MILD Total	MODERATELY SEVERE Improved	MODERATELY SEVERE Not Imp.	MODERATELY SEVERE Total	SEVERE Improved	SEVERE Not Imp.	SEVERE Total
One plus	49 74.8%	11	60	29 46.8%	33	62	3 27.3%	8	11
Two plus	31 70.5%	13	44	17 53.2%	15	32	10 6.3%	6	16
Three plus	19 44.4%	24	43	24 58.5%	17	41	3 30.0%	6	9
Total	99 67.3%	48	147	70 51.8%	65	135	16 44.0%	20	36

Number improved subjectively	185	(58.3%)
Number not improved subjectively	133	(41.7%)
Number of these grounded for aerotitis	22	

Occasionally some of the flying personnel did not have sufficient flying between treatments to constitute a satisfactory test of tubal function. It was arbitrarily decided that five altitude flights would constitute "sufficient flying."

Subjective improvement has been used in this study to mean definite improvement in ear ventilation as stated by the flier. In instances in which the flier had been grounded for aerotitis following the treatment, he was not considered improved subjectively, regardless of his statement.

In the observation of patients after the first treatment, no consistent objective changes were observed. In some cases there was an apparent slight decrease in lymphoid hyperplasia, while in others, no decrease in the hyperplasia could be appreciated.

b. The following table shows the improvement 30 days after two treatments with radium in reference to the previous number of groundings and the amount of lymphoid hyperplasia.

Number given two radium treatments	341	
Number followed up 30 days later	245	(72.0%)
Number without sufficient flying	23	
Number with sufficient flying for evaluation (tabulated)	222	

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD				MODERATELY SEVERE				SEVERE			
	Improved		Not Imp.	Total	Improved		Not Imp.	Total	Improved		Not Imp.	Total
One plus	39	86.7%	6	45	26	70.2%	11	37	4	57.2%	3	7
Two plus	25	78.1%	7	32	12	85.8%	2	14	11	73.4%	4	15
Three plus	20	71.5%	8	28	21	77.8%	6	27	3	42.7%	4	7
Total	84	80.0%	21	105	69	78.5%	19	88	18	62.1%	11	29

Number improved subjectively	171	(77.0%)
Number not improved subjectively	51	(23.0%)
Number of these grounded for aerotitis	15	
Number showing objective decrease in lymphoid hyperplasia	192	(78.4%)

c. The following table shows the improvement 30 days after three treatments with radium in reference to the previous number of groundings and the amount of lymphoid hyperplasia.

Number given three radium treatments	230	
Number followed up 30 days later	132	(57.5%)
Number without sufficient flying	8	
Number with sufficient flying for evaluation (tabulated)	124	

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD Improved	Not Imp.	Total	MODERATELY SEVERE Improved	Not Imp.	Total	SEVERE Improved	Not Imp.	Total
One plus	18 85.7%	3	21	15 75.0%	5	20	2 40.0%	3	5
Two plus	15 100%	0	15	5 62.5%	3	8	3 60.0%	2	5
Three plus	18 81.8%	4	22	19 79.2%	5	24	2 50.0%	2	4
Total	51 87.9%	7	58	39 75.0%	13	52	7 50.0%	7	14

Number improved subjectively 97 (78.2%)
Number not improved subjectively 27 (21.8%)
Number of these grounded for aerotitis 11
Number showing objective decrease in lymphoid hyperplasia 125 (94.6%)

d. The following table shows the improvement 30 days after four treatments with radium in reference to the previous number of groundings and the amount of lymphoid hyperplasia.

Number given four radium treatments 32
Number followed up 30 days later 26 (81.4%)
Number without sufficient flying 1
Number with sufficient flying for evaluation (tabulated) 25

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD Improved	Not Imp.	Total	MODERATELY SEVERE Improved	Not Imp.	Total	SEVERE Improved	Not Imp.	Total
One plus	2 100%	0	2	6 75.0%	2	8	1 50.0%	1	2
Two plus	2 100%	0	2	0	0	0	1 100%	0	1
Three plus	3 60.0%	2	5	3 60.0%	2	5	0	0	0
Total	7 77.8%	2	9	9 69.2%	4	13	2 66.6%	1	3

Number improved subjectively 18 (72.0%)
Number not improved subjectively 7 (28.0%)
Number of these grounded for aerotitis 1
Number showing objective decrease in lymphoid hyperplasia 23 (88.5%)

Observation of cases 60, 90, and 120 days after three treatments with radium and 60 and 90 days after four treatments with radium did not materially change the above findings.

e. From the above series of tables it is apparent that improvement from radium therapy occurs in a higher percentage of cases and earlier in the course of therapy in the less severe cases according to the number of previous groundings.

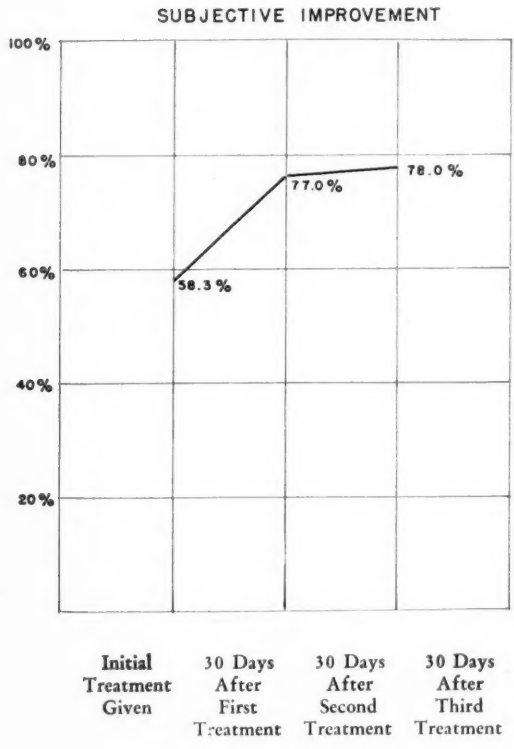

Fig. 1.

In addition, improvement occurs in a higher percentage of cases and earlier in the course of therapy in those cases having less lymphoid hyperplasia.

More than one radium treatment is probably indicated because the percentage of subjective improvement increases with the number of treatments as shown in Fig. 1.

The improvement after radium therapy was also graded as slight, moderate and marked. Those patients who experienced subjective improvement following radium therapy were grouped as follows: 61 per cent had slight improvement, 32 per cent had moderate im-

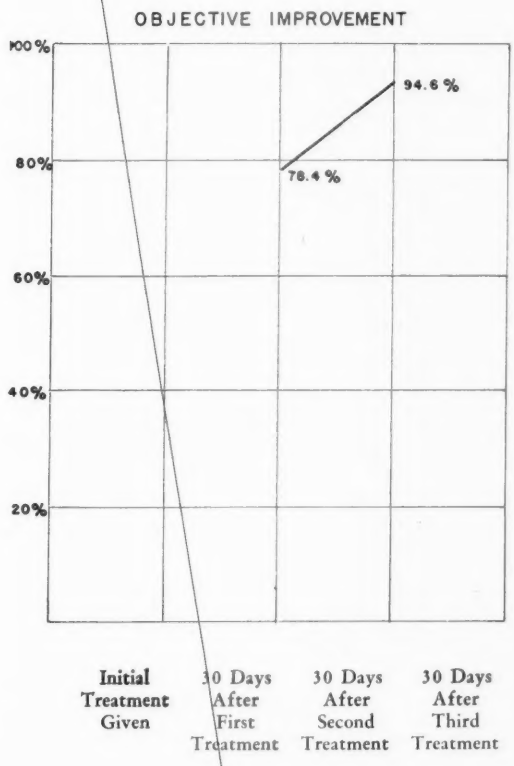

Fig. 2.

provement and 7 per cent had marked improvement. The percentages in this grouping were similar after each of the radium treatments.

Objective decrease in lymphoid hyperplasia is shown in Fig. 2.

The patients who were given four radium treatments were those who had not improved satisfactorily with three treatments, which explains why the percentages for improvement, both subjective and objective, are lower than the corresponding percentages following three treatments.

f. Those cases not followed up are tabulated:

Number Lacking Follow-Up After the Following Radium Treatment	First	Second	Third	Fourth
Completed tour and returned to U. S. and those missing or killed in action	25	54	60	2
Not due for 30 day follow-up (treated less than 30 days before completion of report)	20	28	18	2
Absent from base (T. D., rest home, on leave, etc.)	10	14	20	2
Total	55	96	98	6

5. DATA ON CONTROL CASES.

a. Study of the cases in which treatment was indicated but not given, these cases being used as controls, shows the following subjective improvement during the first 30-day period of observation.

Total number in control group	66	
Number followed up 30 days later	45	(68.2%)
Number without sufficient flying for evaluation	1	
Number with sufficient flying for evaluation (tabulated)	44	

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	Mild				Moderately Severe				Severe			
	Improved		Not Imp.	Total	Improved		Not Imp.	Total	Improved		Not Imp.	Total
One plus	0	0%	6	6	1	14.3%	6	7	0	0%	0	0
Two plus	0	0%	5	5	0	0%	6	6	0	0%	1	1
Three plus	0	0%	8	8	4	40.0%	6	10	0	0%	1	1
Total	0	0%	19	19	5	21.7%	18	23	0	0%	2	2

Number improved subjectively	5	(11.4%)
Number not improved subjectively	39	(88.6%)
Number of these grounded for aerotitis	4	

b. Observation of these control cases followed up 60 days after the first examination shows the following improvement.

Total number in control group	66	
Number followed up 60 days later	31	(47.4%)
Number without sufficient flying for evaluation	2	
Number with sufficient flying for evaluation (tabulated)	29	

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD Improved	MILD Not Imp.	MILD Total	MODERATELY SEVERE Improved	MODERATELY SEVERE Not Imp.	MODERATELY SEVERE Total	SEVERE Improved	SEVERE Not Imp.	SEVERE Total
One plus	1 20.0%	4	5	0 0%	6	6	0	0	0
Two plus	1 33.3%	2	3	2 66.6%	1	3	0	0	0
Three plus	0 0%	4	4	3 50.0%	3	6	0 0%	2	2
Total	2 20.0%	10	12	5 33.3%	10	15	0 0%	2	2

Number improved subjectively 7 (24.1%)
Number not improved subjectively 22 (75.9%)
Number of these grounded for aerotitis 3

c. Observation of these control cases followed up 90 days after the first examination shows the following subjective improvement.

Total number in control group 66
Number followed up 90 days later 21 (31.8%)
Number without sufficient flying for evaluation 0
Number with sufficient flying for evaluation (tabulated) 21

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD Improved	MILD Not Imp.	MILD Total	MODERATELY SEVERE Improved	MODERATELY SEVERE Not Imp.	MODERATELY SEVERE Total	SEVERE Improved	SEVERE Not Imp.	SEVERE Total
One plus	1 33.3%	2	3	0 0%	3	3	0	0	0
Two plus	1 33.3%	2	3	2 66.6%	1	3	0	0	0
Three plus	1 50.0%	1	2	2 40.0%	3	5	0 0%	2	2
Total	3 37.5%	5	8	4 36.4%	7	11	0 0%	2	2

Number improved subjectively 7 (33.3%)
Number not improved subjectively 14 (66.6%)
Number of these grounded for aerotitis 4

d. Observation of these control cases followed up 120 days after the first examination shows the following subjective improvement.

Total number in control group 66
Number followed up 120 days later 12 (18.2%)
Number without sufficient flying for evaluation 0
Number with sufficient flying for evaluation (tabulated) 12

SEVERITY ACCORDING TO PREVIOUS GROUNDINGS

Lymphoid Hyperplasia	MILD				MODERATELY SEVERE				SEVERE			
	Improved		Not Imp.	Total	Improved		Not Imp.	Total	Improved		Not Imp.	Total
One plus	0	0%	2	2	0	0%	1	1	0		0	0
Two plus	0	0%	3	3	1	50.0%	1	2	0		0	0
Three plus	1	100%	0	1	2	66.6%	1	3	0		0	0
Total	1	16.6%	5	6	3	50.0%	3	6	0		0	0

Number improved subjectively 4 (33.3%)

Number not improved subjectively 8 (66.6%)

e. Those cases not followed up are tabulated:

NUMBER LACKING FOLLOW-UP AT THE FOLLOWING OBSERVATION PERIOD

	30-day	60-day	90-day	120-day
Completed tour and returned to U. S. and those missing or killed in action	13	22	25	29
Not due for 30 day follow-up (less than the time indicated)	3	5	17	15
Absent from base (T.D., rest home, on leave, etc.)	5	8	3	10
Total	21	35	45	54

f. Progress of control cases revealed an interesting contrast to those given the usual course of three radium treatments. Of those that could be followed 30 days after the initial examination, 11.3 per cent felt improved; after 60 days, 24.1 per cent felt improved; after 90 days 33.3 per cent felt improved; and after 120 days, 33.3 per cent felt improved. The number of cases followed in this series was comparatively small and in the successive months became smaller (44, 29, 21, and 12 respectively).

6. CONCLUSIONS.

a. Radium therapy is a valuable adjunct to the present methods of treatment of recurrent aerotitis.

b. No untoward reactions to radium therapy in the dosage given were observed during the survey.

c. The subjective improvement following radium therapy was as follows: after the first treatment 58.3 per cent of the cases im-

proved, after the second treatment 77.0 per cent of the cases improved and after the third treatment 78.2 per cent of the cases improved.

d. The objective improvement following radium therapy was as follows: after the second treatment 78.4 per cent of the cases improved and after the third treatment 94.6 per cent of the cases improved.

e. More than one radium treatment is probably indicated because the percentage of subjective improvement increases with the number of treatments.

f. Patients having fewer groundings and a small amount of lymphoid hyperplasia showed greater subjective improvement earlier in the course of treatment.

g. The patients with a history of repeated groundings for aerotitis had a high incidence of ear difficulty in the decompression chamber.

LVII

THE USE OF RADIUM IN THE AEROTITIS CONTROL PROGRAM IN THE TWELFTH AIR FORCE

Major John S. Mikell

Medical Corps, Army of the United States

The irradiation project was conducted in the Twelfth Air Force by one medical officer and one medical corpsman over a period of four months, beginning 21 December 1944 and ending 21 April 1945. All energy was directed toward keeping flying personnel in combat. Because of military exigencies, no control group was maintained as it was felt that any individual whose combat efficiency was impaired by reasons of ear ventilation difficulty and who required treatment should not be denied the benefit of any aid that would permit him better to carry on the war effort.

The mission of the Twelfth Air Force at the time this study was in progress of necessity caused various groups that were under observation to be moved rapidly over widely scattered areas, which markedly complicated follow-up studies. By taking advantage of every mode of transportation, the clinic equipment was moved 20,000 miles by air and 5,000 miles by land, making it possible to follow 201 men (51 per cent) of the original treated group of 394 through a complete course of three treatments and for an additional 30 days.

The travel was accomplished by any type of aircraft and pilot available at the time. All types of land transportation were used (jeep and trailer, ambulance, weapon carrier, train, taxi, subway, bicycle taxi, and a hansom cab). The difficulties of accomplishing land travel from place to place were considerable; of particular note was a jeep and trailer trip across the precipitous Apennines over a tortuous war-torn road, at times above the cloud level. Regardless of the difficulties involved during the active prosecution of the air war against Germany, the flying fighting personnel of the Twelfth Air Force were followed from point to point on a precise schedule over the entire length of Corsica, throughout northern Italy, across France and into Germany.

They were treated in tents, churches, barrooms, messes, hotels, palaces, ballrooms, convents, dispensaries and in hospitals. The personnel so treated were enthusiastic in their appreciation of the fact

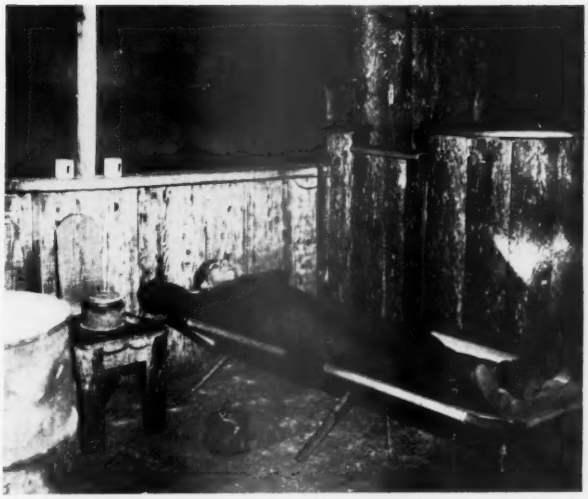

Fig. 1.—Treatment in the field.

that the treatment had been brought to them in the combat area. (Fig. 1)

As was dictated by necessity and experience, the equipment was limited to the bare essentials and consisted of a single metal applicator, cotton, neo-synephrine, 10 percent cocaine, an otoscope, two nasopharyngoscopes, necessary records and the two nasal radium applicators in the increasingly heavy 100 pound lead radium container. Because it was imperative that the integrity of the almost microscopically thin, delicate wall of the monel metal radium-containing chamber be preserved intact (the chamber if cracked, though retaining the radium salt, loses the radon gas and is worthless as a therapeutic destroyer of hyperplastic lymphoid tissue) the radium container was made suitable for immobilization and a "cradling bed" was designed to protect the applicators while being transported over war-torn roads. The protective device was constructed as follows: A small semirigid rubber tube was used as a protective support for the applicators. This allowed the bottom of the handle to rest on the top of the rubber tubing and keep the tip of the applicator separated from the bottom of the tube by a rubber cushion. Noncorrosive metal tubes were used in place of the glass test tubes. Cotton

Fig. 2.—Radium container modified for transportation.

Fig. 3.—Immobilization of container in jeep trailer.

was placed over the top of the applicators. An 18-inch steel plate was attached to the base of the container. A sleeve was placed around the container with six staples attached to permit immobilization and two links of chain were added so that the container could be locked, thereby serving as its own locked safe. The top and bottom lead discs were immobilized (Figs. 2 and 3).

Each individual's record included name, rank, serial number, date of treatment, classification of symptoms and findings, progress and results of treatment. Classification of symptoms and findings were arranged so as to be suitable for coding as follows:

A. *Symptoms and Frequency.*

1. Aerotitis, existing.
2. Aerotitis, repeated attacks.
3. Aerotitis, single previous attack.
4. Nasopharyngitis, repeated attacks.
5. Screening with or without symptoms.

B. *Nasopharyngoscopic Findings.*

a. Large amount of tissue about the eustachian tube orifices.
b. Moderate amount of tissue about the eustachian tube orifices.
c. Small amount of tissue about the eustachian tube orifices.
d. No tissue about the eustachian tube orifice.

From the above it is obvious that a numerical rating could be given each individual flier examined; for example, "2-b" indicates that he had had repeated attacks of aerotitis in the presence of moderate amount of lymphoid tissue complicating the ventilation of his middle ear. The numerical rating of cases lends itself admirably to a punch card system of records, the use of which greatly facilitates a statistical survey.

The criteria for recording positive subjective improvement following irradiation was a definite statement from the flier to the effect that he was having less difficulty ventilating his ears during the rapid changes of altitude coincident with combat flying. The criteria adopted for a recorded objective improvement was a positive gross reduction

of the amount of lymphoid tissue as seen in the nasopharyngoscopic examination, which permitted the individual to be definitely placed in the next lower classification. This criteria introduces the obvious element of human error in the examiner, but this is minimal when it is considered that all patients were examined by the same officer who after hundreds of such examinations had a very clear conception in his own mind of the "lymphoid connotation" of each numerical grade. All flying personnel in this project had an adequate number of exposures to flying so that their subjective changes were valid. Detailed progress data on each individual was recorded on a punch card system.

A total of 704 men were examined on the initial tour of which 394 (56 per cent) were given treatment. The majority of the men received either two or three treatments, but in some instances due to the prosecution of the war their course of treatment was interrupted. It was possible, however, to follow 201 (51 per cent) flying personnel through the entire course of three treatments with an additional 30 day follow-up. Of this group 162 were having difficulty ventilating their ears at the time of the original examination and treatment. Only these men are considered in this report.

NUMBER OF EXAMINATIONS	ORIGINAL NUMBER TREATED	NUMBER WITH SYMPTOMS WITH ADEQUATE FOLLOW-UP
704	394 (55%)	162 (41%)

There were 142 men who were having trouble ventilating their middle ears on descent who were judged to have sufficient lymphoid tissue in and about their eustachian tube orifices to be the cause of this difficulty. From a consideration of Fig. 4, it is evident that the subjective improvement closely parallels the objective improvement (decrease in hyperplastic lymphoid tissue). This is the main positive finding made in this study.

There is a variable tolerance to irradiation and the most resistant cases in this study show no gross reduction in tissue following irradiation therapy and consequently far less (40 per cent) subjective improvement (Fig. 5).

Many of the men showing subjective improvement and recorded as having no objective improvement actually had tissue decrease, but not of sufficient amount to meet the standards set to show objective improvement. This in part explains the number of men reporting subjective improvement but recorded as having no objective improvement.

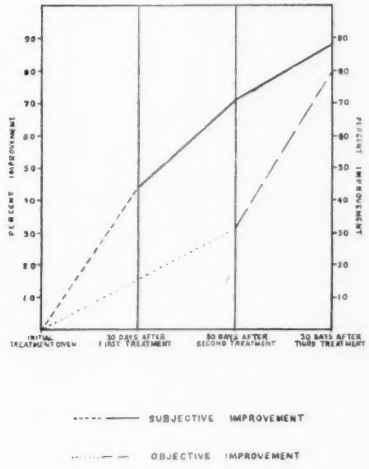

Fig. 4.

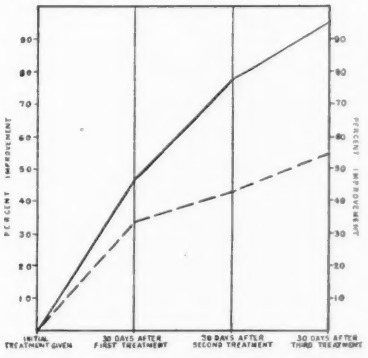

Fig. 5.

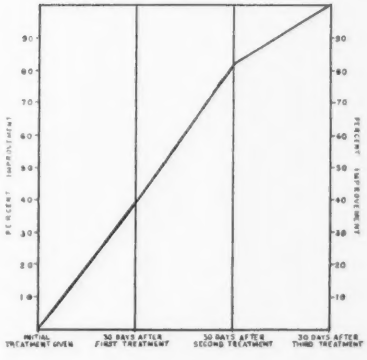

Fig. 6.

Figure 6 represents a group of 20 fliers followed throughout this study who were having considerable ear ventilation difficulty and upon examination showed very little lymphoid tissue in or about the eustachian tube orifices. These were treated and the results are as shown in Fig. 6.

It is rather remarkable that 100 per cent of this group were subjectively improved following treatment. This situation introduced the thought that a large amount of lymphoid tissue is not necessarily the sine qua non of ear ventilating difficulty, but that a very small amount of tissue can be "malignant by position" when located within the eustachian tube orifice. Inflammation of such tissue adjacent to the tube may extend by continuity into the tubal wall itself, further complicating the picture.

There were no undesirable results, either subjectively or objectively, noted during the course of the project in the Twelfth Air Force. The few patients who stated that their symptoms were made more severe showed no visible reaction from the irradiation; the majority of these cases were seen in personnel who usually had other plans than to report to the clinic and on whom considerable pressure had to be brought to secure their presence. Many of the men recorded as improved reported that they had been cured, but no such claim can possibly be made following a study of such short duration. It is definitely the impression of the operator that irradiation played a large part in reducing the incidence and severity of nasopharyngitis, and also permitted many men threatened with aerotitis to continue on full combat duty who without the benefits of irradiation would have been lost to such duty.

CONCLUSIONS

1. Seven hundred four crew members of the Twelfth Air Force were given a careful nasopharyngoscopic examination during the first tour of the Air Force by the irradiation clinic. Three hundred ninety-four (56 per cent) of these men received the initial treatment. One hundred sixty-two of the personnel, all having difficulty ventilating their ears at the time of the original examination, received the prescribed course of three treatments and were followed for an additional 30 days.

2. The results of this study definitely suggest that the presence of hyperplastic lymphoid tissue in and about the eustachian tube orifices impairs the flier's ability to ventilate his middle ear and increases the incidence of aerotitis in the individual.

3. Irradiation is not a cure-all for aerotitis and obviously will not affect symptoms having a functional basis.

4. No undesirable results, either subjective or objective, were noted throughout the course of the study.

5. Irradiation therapy of the nasopharynx by nasal applicators containing radium is the only practicable method of using this type of treatment in the field.

6. Eighty-nine per cent of the patients given the full course of treatment were subjectively improved and 80 per cent of this treatment group showed a gross objective improvement.

LVIII

AEROTITIS PROGRAM IN THE FIFTEENTH AIR FORCE

Captain Tony J. Trapasso
Medical Corps, Army of the United States

The Aerotitis Clinic in the Fifteenth Air Force operated from 9 November 1944 to 21 April 1945. The clinic personnel consisted of one medical officer, especially trained in the use of radium in the nasopharynx, aided by two enlisted men.

The flight surgeons were informed of the availability of the clinic when it arrived in the theatre. They were asked to send in the men who were having or had had aerotitis in the past. At first many men who were not greatly troubled were sent in and those with hyperplastic lymphoid tissue about the tubal orifice were treated. It was later decided that such a program would not be feasible in this combat theatre. Therefore, treatment was confined to those men having considerable difficulty ventilating their ears and having objective findings in the nasopharynx. Even this small group in great need of treatment could not be followed completely because of the rapid turnover of personnel.

The clinic travelled between bomb groups by jeep and trailer (Fig. 1). Most of the units were situated within a 50 mile radius and only one was two hundred miles from the clinic base station. Equipment for the clinic was carried in a foot locker and the radium applicators in a lead container. The clinic would locate in any building with adequate floor space. Chapels, dispensaries, convents, theaters, or clubs were utilized. An appointment schedule and patient lists were drawn up and submitted to each bomb group before every monthly visit. Table 1 shows the scope of the work in the Fifteenth Air Force.

Table 1.—Scope of Aerotitis Program in the Fifteenth Air Force

Total number of men examined	1580
Number of initial treatments given	1002
Total number of treatments given	2000
Men observed 30 days or more after 3 treatments	91

The total number of men given initial treatments was large because it included a prophylactic survey conducted on a heavy bom-

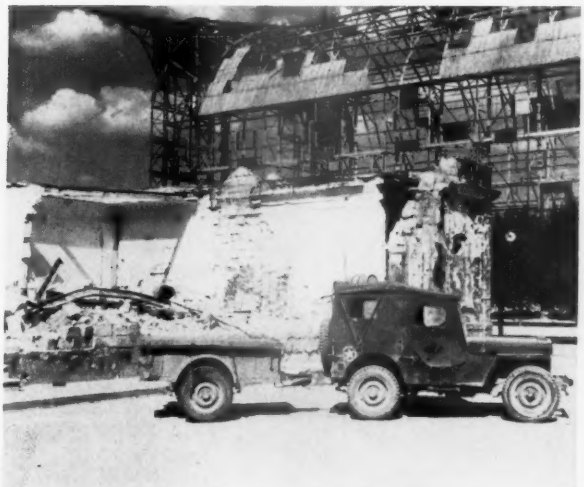

Fig. 1.—Jeep and trailer used by mobile aerotitis clinic in Fifteenth Air Force parked at one heavy bombardment group.

bardment group. Men in this survey were those with lymphoid tissue about the tubal orifice who had had very little difficulty ventilating their ears on descent. The final results of the prophylactic survey are not available because adequate study and follow-up were interrupted by the sudden termination of combat flying. As has already been explained, continued treatment on the group without repeated attacks of aerotitis was not considered practical or advisable in this combat theatre.

The number of men under treatment was too small to cause any apparent decrease in the incidence of aerotitis in this Air Force. However, it was noted that the number of cases appearing before the medical disposition board for aerotitis was markedly reduced.

Table 2 shows that 30 per cent of the men with repeated attacks of aerotitis and hyperplastic lymphoid tissue about the tubal orifice gave a past history of suppurative ear infection. These men derived less benefit from the treatments than those without an antecedent suppurative ear infection. It also shows that retraction of the ear drum is a common finding in men who have had many attacks of aerotitis. The table also reveals that over half of the men examined

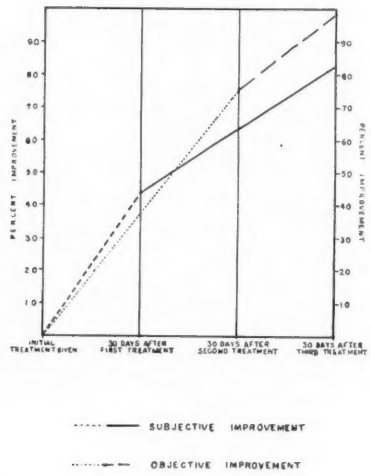

Fig. 2.

had lymphoid tissue about the tubal orifice and that almost all of them had tissue in the fossa of Rosenmüller.

TABLE 2.—FINDINGS ON HISTORY AND EXAMINATION OF 91 MEN OBSERVED MORE THAN 30 DAYS AFTER 3 TREATMENTS.

	NO.	PERCENT
Past history of suppurative ear infection	36	30
Retraction of tympanic membrane	71	78
Lymphoid tissue in fossa of Rosenmüller	81	89
Lymphoid tissue in eustachian tube orifice	52	57
Lymphoid tissue on posterior wall of nasopharynx	61	68

Table 3 shows the percent of subjective and objective improvement in the 91 men followed for at least 30 days after each treatment. This is also demonstrated graphically in Fig. 2.

TABLE 3.—PERCENT OF IMPROVEMENT IN 91 MEN EXAMINED 30 DAYS AFTER EACH TREATMENT.

30 days after treatment number:	*1*	*2*	*3*
Subjectively improved	44%	64%	81%
Objectively improved		76%	98%

Study of 17 cases that did not respond to treatment revealed the following causes as probable reasons for failure:

1. Severe suppurative ear infection in childhood or previous suppurative aerotitis media attacks.
2. Many attacks of aerotitis media, but without suppuration.
3. Allergy or vasomotor rhinitis syndrome state.
4. Psychoneurotic trend with magnified aerotitis symptoms.
5. Resistant lymphoid tissue.
6. Undertreatment.

Three case histories are presented to illustrate the different types of cases seen.

REPORT OF CASES

CASE 1. 1st Lt. P. S. M., Pilot, B-17, age 24, 900 hours total flying time, 300 hours at 15,000 feet or above, 26 missions.

Past History. This patient had had a tonsillectomy under local anesthesia, suppurative bilateral ear infections in 1928 and 1943, and constant colds.

Aerotitis History. He had had constant severe trouble ventilating the right ear on each flght and tubal obstuction on the ground with "colds." There had been promiscuous use of nose drops and frequent visits to the flight surgeon before and after each flight. He was grounded 20 days for aerotitis in the past and was first seen for an attack that started four days before. He had an aerotitis media tic on the ground manifested by repeated protrusion and retraction of the jaws. This tic was evident to those who saw him walking about the group area.

Examination. Both ear drums were retracted and scarred. There was granular lymphoid tissue on the posterior pharyngeal wall. Examination with the nasopharyngoscope revealed a considerable amount of lymphoid tissue in the fossa of Rosenmüller.

Course. After the second treatment the tic disappeared, he no longer bothered the flight surgeon for treatment, and the lymphoid tissue had been eliminated. During the period of 96 days that he was under observation he had flown 19 times above 10,000 feet and had lost but one day of flying time due to one attack of aerotitis that only lasted one day. The ears still plugged on descent for a few

hours but he was not under any discomfort and no longer had a "cold." He stated that he would have been permanently grounded if his ears had not improved.

CASE 2. T/Sgt. C. A. M., Eng.-Gunner, B-17, age 22, 400 hours total flying time, 100 hours flying above 15,000 feet, 15 missions.

Past History. He had had a tonsillectomy and adenoidectomy under general anesthesia; few head colds.

Aerotitis History. He had constant trouble ventilating his ears during each flight. He was grounded 25 days in the past and five days for the present attack associated with a head cold.

Examination. There was retraction of the right drum, a septal spur, right, and lymphoid tissue in the pharynx in the form of lateral bands and granular posterior wall. Nasopharyngoscopic examination revealed a mass of lymphoid tissue covering both tubal orifices.

Course. Twenty-six days following the first treatment he noticed definite improvement. He had flown six times at altitude and his ears plugged for only one day instead of five. During 41 days after the second treatment he flew three times, and during the 31 days after the third treatment he flew six times. His ears no longer plugged and he felt he was completely "cured." Examination with the nasopharyngoscope after the third treatment revealed complete disappearance of the large mass of lymphoid tissue.

CASE 3. T/Sgt. F. X. M., Eng.-Gunner, B-24, age 22, 300 hours total flying time, 200 hours above 15,000 feet, 19 missions.

Past History. This patient had had a tonsillectomy and adenoidectomy under general anesthesia; few head colds.

Aerotitis History. There was deafness in the right ear and plugging of both ears both in flying and in the pressure chamber test. He was grounded five months in the past for deafness and aerotitis and lost 35 days at the time of his first visit for the present attack. What little flying he did was at low altitudes and not in combat.

Examination. There was retraction and scarring of both drums, and granular lymphoid tissue on the posterior wall of the pharynx. Examination with the nasopharyngoscope revealed lymphoid tissue

in the fossa of Rosenmüller and in the tubal orifices. Simple hearing tests revealed normal hearing.

Course. The lymphoid tissue was eliminated after the first treatment. He never flew at high altitude again and was eventually grounded permanently after the third treatment because of deafness in the right ear. It was felt by the Medical Disposition Board that this man was a psychoneurotic.

LIX

SUMMARY OF THE COMBINED REPORT

Aerotitis, due to inability to ventilate the middle ear during flight, has been a major cause of disability in flying personnel. A program to reduce the incidence of aerotitis in the Army Air Forces was instituted in 1944 by the Air Surgeon. The attack was based primarily on the elimination of the most common cause of eustachian tube malfunction, namely, hyperplastic lymphoid tissue in the nasopharynx. Irradiation of such tissue with radium was chosen as the best and most practical method of treatment for the desired purpose. The rationale of radium therapy is that hyperplastic lymphoid tissue about the eustachian tube orifice regresses following treatment. It removes not only a mechanical factor which predisposes to aerotitis but also tissue that harbors pathogenic organisms that precipitate attacks of nasopharyngitis. These infections not only increase the susceptibility of the flyer to aerotitis, but in themselves are responsible for much loss of flying time.

The present report is based on studies conducted on flying personnel in the European and Mediterranean Theatres of Operation, by medical officers attached to the Eighth, Twelfth and Fifteenth Air Forces, and in the United States to the First and Third Air Forces. All of the officers engaged in the program were otolaryngologists who were specially trained in the use of the nasopharyngoscope and in the technique of nasopharyngeal irradiation.

Every patient was examined with a nasopharyngoscope, and every patient selected for treatment had hyperplastic lymphoid tissue in or about the eustachian tube orifices. Overseas, only the patients with a history of aerotitis or ear-ventilating difficulties were treated. In the United States, in addition to patients of this type, a large number with no history of aerotitis but with hyperplastic lymphoid tissue in the nasopharynx, were treated on a prophylactic basis.

A total of 14,345 men were examined by the participating units and 6,881 were selected for treatment. The total number of treatments given was 14,045. Not a single instance of burn or ulceration of the nasopharyngeal or the nasal mucous membrane occurred in the 14,045 treatments given. A very small proportion of the men had a mild stuffiness of the nose, a slight sore throat or a sensation of a head cold after treatment.

The constant shifting of men from this country to combat duty overseas and the difficulty of following the men in combat areas are responsible for the fact that only 1,129 men out of the 6,881 selected for treatment were available for observation 30 days or more after treatments were completed. All conclusions are based upon study of this group.

Of 636 men with a history of recurrent aerotitis, 74 per cent had less difficulty ventilating their ears during flight and 89 per cent had a marked decrease in the amount of nasopharyngeal lymphoid tissue when examined with a nasopharyngoscope 30 days or more after the third treatment. Seventy men, or 11 per cent, showed no reduction in the amount of lymphoid tissue in the nasopharynx, and 165 men, or 26 per cent, had no subjective improvement.

The beneficial effect of prophylactic irradiation was shown by the drop in incidence of aerotitis in 778 men after high altitude flights. Following the completion of treatment, the incidence of aerotitis in this group was reduced from twice that in a control group of 922 men with normal nasopharynges to a level almost identical with the control group.

The value of irradiating minimal amounts of lymphoid tissue located in critical areas about the tubal orifice was shown by the effect of treatment of 66 men in this category who had previous ear-ventilating difficulties. After completion of therapy, subjective improvement was reported by 55 of the men.

The principal cause of failure to improve after irradiation treatments was the presence of a large mass of adenoids. For such patients, surgical removal, supplemented by irradiation, would have been more effective. Other men had lymphoid tissue in smaller amounts which did not respond to radium treatments of the dosage employed. In other patients the lymphoid tissue decreased in size following irradiation, but no improvement in ear-ventilating ability was noted. In these men various factors, such as nasal allergy, chronic sinusitis and psychologic reactions were found to be contributing causes for the lack of improvement.

Basic precautions were adopted to protect medical personnel and patients from overexposure to irradiation. For those giving the treatments the principal safety measure was distance. Except when placing or removing the applicators from the nasopharynx, all personnel remained at a distance of 20 feet or more. The applicators were cleaned with a brush, not by wiping with the fingers, and great care

was taken to time the treatments accurately. No evidence of overexposure, either of patients or of irradiation clinic personnel, was noted by any of the participating officers.

CONCLUSIONS

1. The use of the nasopharyngeal radium applicator is a safe, practical and effective method of irradiating hyperplastic lymphoid tissue in the nasopharynx.

2. The data submitted by six independently operating groups of investigators show that irradiation of the nasopharynx causes a regression of lymphoid tissue and definitely improves ability to ventilate the middle ear.

3. Irradiation of hyperplastic lymphoid tissue about the eustachian tube orifice is an effective prophylactic measure for aerotitis in flying personnel.

4. It is apparent from the results obtained in this study that radium therapy is an advance in the control of recurrent aerotitis.

LX

SOME FURTHER EXPERIMENTS IN THE PRODUCTION OF NEGATIVE PRESSURE IN THE TRACHEA AND THE FRONTAL SINUS BY CILIARY ACTION

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The results of some experiments demonstrating the production of negative pressure in the respiratory tract by ciliary power were published a year ago. It was found that when the cilia moved, within an air passage, a mass of mucus sufficiently large to fill the lumen a negative pressure developed behind the mass. The principle seemed to be that of piston-cylinder action. It was demonstrated repeatedly in the excised tracheas of freshly killed hens. The hypothesis that this phenomenon could explain postoperative atelectasis was presented.[1] Since that time there has been some friendly criticism to the effect that: first, perhaps the negative pressure was due to absorption of air by the blood stream and not to removal by ciliary action; second, although the negative pressure found might be due to ciliary action, it was insufficient in magnitude to account for the negative pressure found in atelectasis.[2] It was demonstrated that absorption played no role in the negative pressure obtained in excised tracheas of hens because by reversing the position of the trachea with reference to the manometer, a positive pressure was recorded.

The phenomenon was also demonstrated in the frontal sinuses of dogs.

It seemed improbable that the scanty blood flow through the mucous membrane of a dog's normal frontal sinus could absorb air fast enough to account for the fall in pressure obtained in these experiments, but it was a definite possibility and therefore should be investigated.

Technic. The following experiments were carried out on dogs to determine the role of absorption of air from the sinus.

From Department of Ophthalmology and Otolaryngology, University of Minnesota. Experiment done in Department of Physiology and in the Division of Experimental Medicine, Mayo Foundation, Rochester.

With the animal under ether anesthesia and with observance of aseptic technic, two 16-gauge hypodermic needles were inserted into one frontal sinus of a dog. The needles were introduced through small holes made through the scalp and bone. Each needle fitted into both the skin and the bone effectively enough to be airtight. One needle was connected to a syringe containing the mucinous secretion to be injected and the other was connected to a water manometer. A third needle was introduced into the opposite frontal sinus and connected to another water manometer which acted as control.

The mucinous secretion was collected from the trachea of either the dogs used in these experiments or other dogs.

Experiment 1. Five cubic centimeters of foamy mucus was injected into the left frontal sinus of Animal 1 at 11:18 a. m. The manometer reading stood at zero at 11:20. Negative pressure then began to develop and increased steadily to a maximum of -38 mm. of water in 18 minutes. It varied between -36 and -38 for seven minutes and then changed to -34 where it stood at 11:49. The animal was decapitated at 11:50 and the needles were removed and cleaned.

Experiment 2. The needles were reinserted into the same sinus of the decapitated head and 6 cc. of mucus was injected at 11:59. Immediately after injection, the manometer reading stood at zero. Negative pressure began to develop after a minute or two and reached a negativity of -16 mm. 13 minutes after injection and 22 minutes after decapitation of the animal. The readings varied during the next 20 minutes between -8 and -22 mm. When the experiment was concluded at 12:32 p. m., the pressure was -16 mm.

Experiment 3. At 10:21 a. m., 6 cc. of foamy mucus was injected into the right frontal sinus of Animal 2. A slight positive pressure (plus 10 mm. of water) was recorded on the manometer immediately (Fig. 1) but it passed the zero mark and became negative during the second minute and at 10:23 the reading was -6 mm. The negative pressure increased to -28 mm. during the next 6 minutes. Then a leak seemed to develop about the needle and a larger sized needle was substituted. At 10:35 the pressure was again -7 mm. and negativity progressively developed to reach a maximum of -36 mm. 19 minutes later (10:54 a. m.).

The dog was then bled to death. The femoral artery was cannulated and exsanguination begun at 11:05. When respirations ceased 3 minutes later the pressure stood at -30 mm. and at 11:16 at -25 mm.

NEGATIVE PRESSURE IN FRONTAL SINUS.

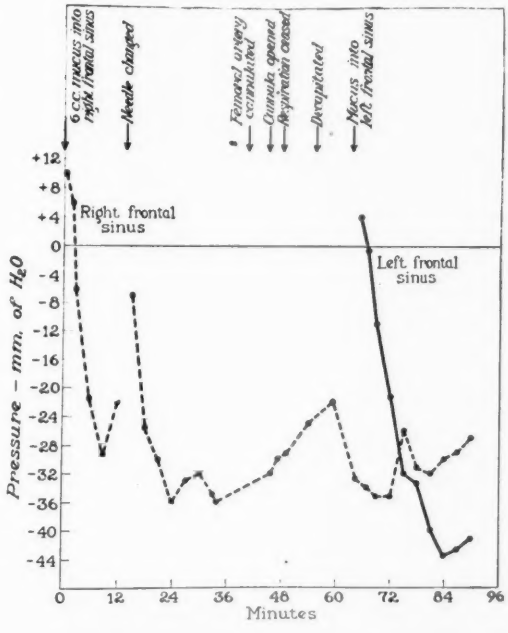

Fig. 1.—Pressures recorded in Experiments 3 and 4. Experiment 3 was performed upon the right frontal sinus of Dog 2. Six cc. of mucus was injected and the pressure recorded (broken line) during and after exsanguination and decapitation. Experiment 4, done upon the left frontal of the same head, was not begun until after decapitation. The pressure drop was somewhat greater in the left frontal after death than in the right frontal before death, but the curves were otherwise essentially the same. These experiments exclude the possibility of absorption of air by the blood stream as the cause of the observed negative pressure.

The animal was decapitated at 11:18 without disturbing the needles. At 11:19 the pressure was -22 mm.; then for some unknown reason the change of pressure reversed and negativity increased again to -34 mm. 19 minutes after respirations had ceased (11:27). The pressure varied between -24 and -34 until the experiment was terminated at 11:50, 42 minutes after death of the animal and 32 minutes after decapitation.

Experiment 4. Meanwhile 7 mm. of mucus was injected into the left frontal sinus of the same head and the sinus connected with a

second manometer at 11:24, 6 minutes after the animal has been decapitated. A pressure of plus 4 mm. was indicated one minute later and 3 minutes later the reading was -1 mm. An increasing negative pressure developed until, 20 minutes after injection, it amounted to -43 mm. When the experiment was terminated, 26 minutes after the injection of mucus (11:50), the pressure was -41 mm. (Fig. 1).

Comment. By decapitating the animals, the possibility of blood circulating through the sinus mucosa was removed. The negative pressure produced in the left frontal sinus was measured before decapitation in Experiment 1. The maximal negative pressure recorded was -38 mm. of water. Experiment 2 was performed upon the same sinus after decapitation, repeating the steps of the first experiment. A definite negative pressure was again obtained, but not quite so great: namely, -22 mm. In Experiment 3, the pressure in the right frontal of Dog 2 was observed through the process of exsanguination and after decapitation without disturbing the needles. The pressure varied somewhat, but fell practically as low after decapitation as before. The process was repeated on the left frontal sinus of the decapitated head of Dog 2. This time a greater negative pressure was obtained than in the right sinus either before or after decapitation. Since the phenomenon can be produced equally readily immediately after death as before, one must conclude that it is not due to absorption of air by the blood stream.

Cumulative effect of increasing numbers of mucus pistons. The negative pressure obtained in excised tracheas of hens did not exceed 55 mm. of water. It is true that this negative pressure is not comparable to that found in massive collapse in man, for instance, but it seemed to me that it could nevertheless be significant. If -55 mm. of pressure could be produced in an excised piece of hen's trachea with one piston (or plug) of mucus, it seemed probable that pressure variations of much greater magnitude would develop in the larger respiratory tract of a living, intact patient where many pistons of mucus might form in longer tubes. Some of those who discussed the former paper were of the opinion that the pressure changes would be no greater with several pistons than with one.[2] In order to determine the facts in the matter, some further experiments were undertaken.

Excised tracheas from freshly killed hens were used together with human mucus. This mucus was collected from the maxillary sinus of a patient who was in the late stages of an attack of acute

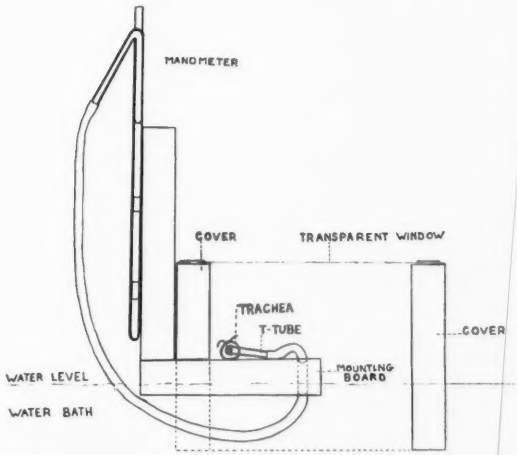

Fig. 2.—Diagram of the cross section of the apparatus in which the tests upon hens' tracheas were made. The apparatus was floated in a constant temperature water bath. The tracheas lay, during the experiments, in a closed chamber containing air saturated with water. The manometers were mounted on the back of the apparatus and connected to the tracheas as indicated.

sinusitis. By means of previous tests, it had been determined that the ciliary mechanism in the hen would readily carry this human mucus.*

Technic. A series of three or four tracheas from freshly killed hens were mounted in series in the apparatus pictured in Fig. 2. The upper end of each was connected to the lower end of the next trachea by means of rubber and glass connections containing a T tube (Fig. 3). The upper end of each trachea was also connected to its own water manometer by means of this T tube. By clamping the rubber tube in the connections, each trachea could be isolated from the others and made to record its own pressure only. The excised tracheas included portions of the primary bronchi in the first experiments. One bronchus was used to make the connection with the next trachea in line while the other bronchus was left open and was used for injection of mucus. By leaving the latter bronchus open and clamp-

*This is contrary to my previous opinion based upon the fact that the commercial mucus (bovine) seemed to stop promptly the ciliary action in laboratory animals such as the dog and the rabbit.

ing the rubber connection, each trachea acted as a unit completely isolated from the others. By unclamping the rubber connections and clamping the open bronchi, the whole series became in effect a single tube with water manometers connected at intervals along its length. When mucus was injected into the open bronchus on each trachea and the rubber connections between the tracheas clamped, each trachea recorded a positive pressure on its manometer produced by its own cilia acting upon the contained mucus. When the rubber connections were unclamped and the open bronchi clamped, then the first trachea would record its own pressure in its own manometer. The second manometer should show the combined pressures produced by the first two tracheas if there were a cumulative effect. The third should show the first three and the last should record the cumulative effect of all.

It was learned after a few trials that the bronchi were more of a nuisance than a help. They would become obstructed with mucus when they should have remained open and when mucus was injected through them, it would sometimes back up into the glass or rubber connections. Consequently in most of the experiments, the tracheas were cut at the lower end, somewhat above the bifurcation. The mucus was injected directly into the lower ends of these tracheas and the connections made subsequently and immediately.

As soon as the tracheas were mounted, the entire apparatus was floated in a constant temperature water bath at 104° F., and covered to prevent drying. The chamber containing the tracheas was floored partly by the board upon which the tracheas were mounted and partly by the surface of the water (Fig. 2). Thus they lay in an atmosphere saturated with moisture at a temperature of 104° F. The cilia maintained their activity for several hours under these conditions. When not in use, the tracheas were kept within a sealed bottle moistened with Ringer's solution and immersed in the water bath. All pressures are recorded in millimeters of water.

Protocols. Experiment 5. At 4:30 p. m. four hens were killed by decapitation and the tracheas including a portion of both main bronchi were dissected out intact and dropped into a bottle immersed in the water bath (40° C. or 104° F.). The bottle had first been wet by Ringer's solution, but contained only a few drops. When all had been dissected and prepared, they were mounted in the floating apparatus shown in Fig. 2. Mucus was injected into the open bronchus of each trachea at 6:10. It was intended to leave these bronchi open during the first part of the experiment, but apparently

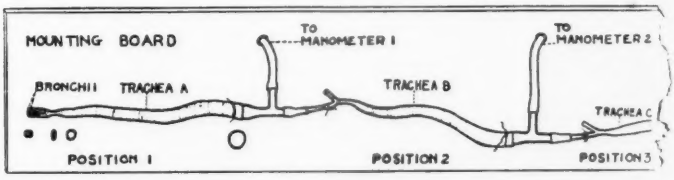

Fig. 3.—Mounted tracheas as seen from above, showing the manner in making connections. The direction of ciliary flow is from left to right. It was not possible to use multiple pistons in a single trachea for the purposes of these experiments because rate of flow varied in different portions of the trachea, because the rate of flow decreased with the passage of time, and because the size and shape of the lumen varied so greatly (cross section at various points is indicated just below Trachea A).

most became blocked immediately with mucus, water and reticular tissue because there was little apparent difference when they were later clamped at 6:35, excepting in B. B recorded the same pressure as A before clamping and rose sharply immediately after clamping (Fig. 4.). The pressures in millimeters of water recorded in the four manometers were as follows:

TIME	MANOMETER 1 TRACHEA A	MANOMETER 2 TRACHEA B	MANOMETER 3 TRACHEA C	MANOMETER 4 TRACHEA D
6:23	4	22	44	76
6:27	4	18	52	90
6:29	8	22	60	110
6:30	8	22	64	110
6:32	10	10	64	110
6:35	Open bronchi clamped.			
6:36	18	32	78	110
6:39	12	34	82	110
6:45	8	40	96	110
6:47	Lower end of D opened.			

Tracheas dismounted. It was found that the T tube connected to D was blocked with mucus.

Experiment 6. At 2:50 p. m. four hens were killed by decapitation and the tracheas and the primary bronchi dissected out and dropped into a bottle immersed in the water bath (40° C.) and wet inside with Ringer's solution. At 3:30 p. m. mounting of the tracheas was begun and at 4:00 p. m. .5 cc. of mucus was injected into each

Cumulative Cilia Effect

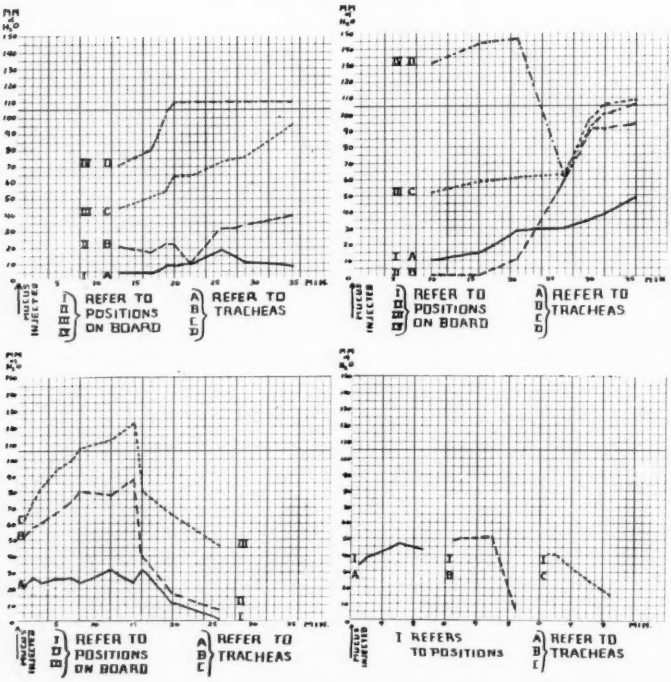

Fig. 4.—Experiment 5. Four tracheas A, B, C, and D, dissected from four freshly killed hens were mounted in series. The direction of ciliary flow was from A toward D. The pressure in each was recorded and is shown in the four curves. The ordinate indicates millimeters of water pressure and the abscissa the time in minutes. The cumulative effect of the four pistons of mucus is clearly shown by the progressively higher pressures from A to D in the four manometers (direction of ciliary flow.) The stationary reading of 110 mm. in D was due to blockage of the manometer tube with mucus.

Fig. 5.—Curves showing pressures in four hens' tracheas used in Experiment 6. Again the cumulative effect is clearly shown. There was evidently a leak in Trachea B at first as no pressure was recorded in the corresponding manometer. By wrapping the loose reticular tissue outside the trachea more closely about it, the leak was apparently stopped and the pressure went up well above that of A. The pressure reached the record height of 146 mm. in D and then the piston must have broken, because the pressure sagged down to that in Trachea C. In fact it went a few millimeters below C—the only time the pressure in any trachea dropped below that of one mounted behind. This paradox was probably due to a flaw in the manometer or its connections.

Fig. 6.—Pressures recorded by the three tracheas used in Experiment 7. Once more the cumulative effect of multiple pistons of mucus is clear. At the 15th minute the piston in B seems to have weakened suddenly and the pressure dropped 46 mm. to with within 10 mm. of A. However, this small difference was maintained until the end of the experiment. Meanwhile when B broke 46 mm. C broke 42 mm.—almost the same—indicating that the piston in C had lost that much support. The difference between the pressures in B and C, however, continued to grow greater even as both curves went down due to weakening in A. This indicated continuing increase of pressure by the piston in C.

Fig. 7.—Curves representing the pressures obtained in three separate tracheas in Experiment 8. These same tracheas were connected in series and used in Experiments 9, 10 and 11. The positions of the individual tracheas on the mounting board were changed in such manner that each trachea eventually had occupied each of the three positions.

trachea through the open bronchus. Difficulty was experienced in getting it in. The open bronchi were then clamped and the readings noted and recorded (Fig. 5). They were found to be as follows:

TIME	MANOMETER 1 TRACHEA A	MANOMETER 2 TRACHEA B	MANOMETER 3 TRACHEA C	MANOMETER 4 TRACHEA D
4:10	10	0*	52	132
4:16	20	0	58	144
4:21	28	12	62	146
4:27	30	60	64	62
4:30	34	92	96	92
4:32	38	92	106	100
4:36	48	94	108	106

*Trachea B apparently leaked air. After several attempts, it was seemingly sealed by shifting the tissue on the outside of the trachea because the manometer began to record pressure after this was done.

The tracheas were dismounted, cleansed in warm Ringer's solution and three of them used again for the next experiment.

Experiment 7. Three of the tracheas used in the previous experiment were washed in Ringer's solution and the lower end including the bronchi cut away and discarded.

At 5:30 p. m. the three tracheas were mounted in the apparatus and at 5:45 p. m. 0.25 cc. of mucus was injected into the lower end of each and then all were connected in series with a T tube connected to a water manometer at the upper end of each (Fig. 6).

Readings recorded on the manometers were as follows:

TIME	MANOMETER 1 TRACHEA A	MANOMETER 2 TRACHEA B	MANOMETER 3 TRACHEA C
5:46	22	52	62
5:47	26	58	74
5:48	24	60	82
5:50	26	66	94
5:52	26	74	100
5:53	24	80	106
5:57	32	78	112
6:00	24	88	122
6:01	32	42	80
6:05	12	16	65
6:11	0	6	46

Experiments 8, 9, 10, and 11 were all performed upon the same tracheas and were designed to show the effect of varying the respective positions of the tracheas used. At the end of the experiments each of the three tracheas had occupied all three positions in the apparatus and had been connected to each one of the three manometers.

At 2:00 p. m. three hens were killed by decapitation. At 2:10 p. m. dissection of the three tracheas was completed; all were immersed in Ringer's solution at 40° C. (The tracheas in the former experiments were not immersed.)

Experiment 8. All three tracheas were mounted in the testing apparatus separately, each connected by its upper end to its own water manometer. Each manometer recorded the pressure in only one trachea (Fig. 7). Mucus was injected into the lower end of each with the following results:

TIME	MANOMETER 1 TRACHEA A	MANOMETER 2 TRACHEA B	MANOMETER 3 TRACHEA C
2:37	34	48	36
2:38	38	50	36
2:42	46	52	26
2:45	44	6	16

Experiment 9. The three tracheas used in Experiment 8 were emptied, cleansed with Ringer's solution and remounted in series.

At 3:05 p. m. mucus was injected into each and the connections were made. The manometers indicated the following pressures. (Fig. 8*a*).

TIME	MANOMETER 1 TRACHEA A	MANOMETER 2 TRACHEA B	MANOMETER 3 TRACHEA C
3:10	32	58	60
3:10	32	64	64
3:15	36	86	86
3:16	36	88	88
3:20	38	90	90
3:23	48	78	80
3:25	48	74	76
3:26	62	60	62
3:27	54	54	56
3:28	48	52	54
3:30	46	50	52
3:34	34	40	40
3:37	6	6	8

Cumulative Cilia Effect

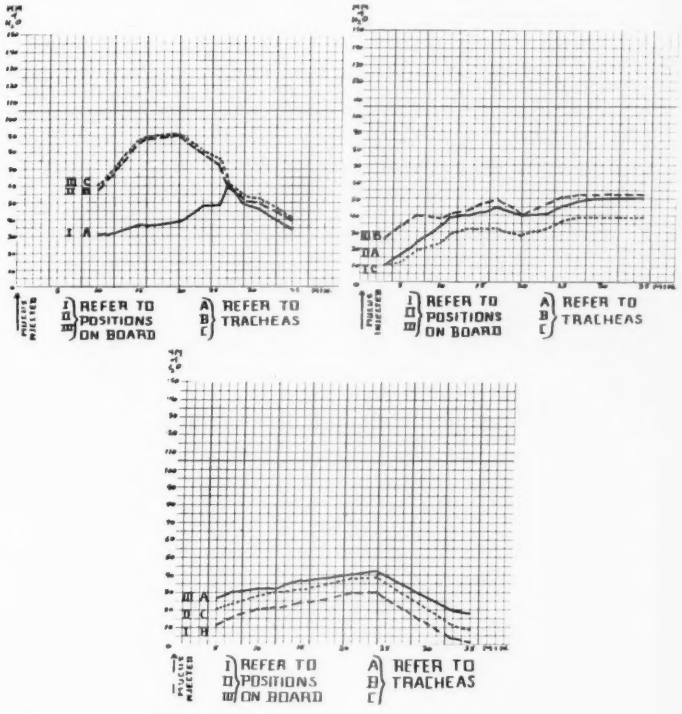

Fig. 8*a*.—In this experiment (9) tracheas A, B, and C were placed respectively in positions I, II and III.

Fig. 8*b*.—In this experiment (10) the positions were changed so that A, B, and C occupied positions II, III and I respectively.

Fig. 8*c*.—In Experiment 11, A, B, and C were in positions III, I and II. Thus each trachea had been placed in each of the three places in the series. Despite these changes, the number one manometer always recorded the lowest pressure and number three the highest, no matter which of the three tracheas were connected. These experiments also indicate a cumulative effect of multiple pistons of mucus in a tube lined by active cilia.

The apparatus was opened and the tracheas were removed, labeled and immersed in warm Ringer's solution.

Experiment 10. The same tracheas used in Experiment 8 were used again in this experiment, but their positions altered. C was placed in No. 1 position and A and B in positions 2 and 3 respectively.

At 4:00 p. m. mucus was injected into the lower end of each and all three connected in series. The following pressures resulted (Fig. 8*b*).

TIME	MANOMETER 1 TRACHEA C	MANOMETER 2 TRACHEA A	MANOMETER 3 TRACHEA B
4:03	10	10	26
4:05	12	16	34
4:07	18	24	40
4:10	24	34	38
4:11	28	38	40
4:13	32	40	42
4:15	32	42	46
4:17	32	44	48
4:20	28	40	40
4:23	32	42	46
4:25	36	46	50
4:27	38	48	52
4:29	38	50	52
4:33	38	50	52
4:35	38	50	52

The tracheas were removed and cleansed in Ringer's solution.

Experiment 11. The three tracheas used in Experiments 8 to 10 were remounted again in different positions for this experiment. This time B was placed in number 1 position and C and A in positions 2 and 3 respectively. At 4:50 the tracheas were mounted and at 4:55 .666 cc. mucus was injected into the lower end of each. At 5:00 the tracheas were connected in series and the apparatus floated in the water bath.

The pressures were found to be as follows (Fig. 8c).

TIME	MANOMETER 1 TRACHEA B	MANOMETER 2 TRACHEA C	MANOMETER 3 TRACHEA A
5:00	12	20	26
5:02	16	24	30
5:05	20	28	32
5:07	22	30	32
5:10	24	32	36
5:16	30	38	40
5:19	30	38	42
5:28	4	12	20
5:30	2	10	18

Comment. Experiments 5 to 11 inclusive indicate a cumulative effect on the pressure produced by ciliary power when three or four tracheas were mounted in series. Each additional trachea added to the first showed an added increase of pressure. The highest pressure recorded in 23 previous experiments on excised tracheas from hens was 55 mm. of water and only one reached this magnitude. In the experiments recorded here, 9 of 20 tracheas mounted in series showed pressures above 55 mm., and 4 exceeded 100 mm. The highest pressure recorded was 146 mm.

In Experiment 5, the glass connection leading to Manometer 4 became obstructed with mucus after 20 minutes when the pressure stood at 110 mm. This accounts for the fact that the pressure remained the same thereafter (Fig. 4). The mucus piston in Trachea B apparently gave way at the 22nd minute causing the pressure to drop down to that of Trachea A. These sudden drops in pressure occur frequently, apparently because the mucus piston grows thin and ruptures. It may or may not reform.

Experiment 6 (Fig. 5) shows another such sudden drop in Trachea D. After the break, the pressure recorded in this trachea was a few mm. below Trachea C. This is the only instance in which the pressure in any trachea fell below that in any trachea mounted behind. It was probably due to a flaw in the manometers, or their connections. Trachea B leaked in the beginning of this experiment and recorded no pressure until the loose reticular tissue on the outside of the trachea was shifted about to enclose it. Tracheas C and D showed very little pressure above B after the 27th minute. The pressures recorded in Manometers 3 and 4 thereafter were produced largely by Tracheas A and B.

Experiment 7 (Fig. 6) shows the cumulative effect better than any of the others. The rises of pressure in Manometers 1, 2 and 3 between the first reading and the end of 14 minutes were respectively 10 mm., 36 mm., and 60 mm. The highest readings were respectively 32, 88 and 122 mm. The pressure in Manometer 2 suddenly broke at the 15th minute from 88 to 42 mm. and sagged to within 10 mm. of Manometer 1. This break was presumably due to a sudden weakening of the piston in Trachea B. This difference of 10 mm. between Manometers 1 and 2 was maintained until the end of the experiment. Meanwhile when the pressure in Manometer 2 fell 46 mm., the pressure in Manometer 3 fell 42 mm., but the difference between the two was maintained until the end of the experiment.

Experiments 8 to 11 were all done on the same three tracheas. The individual pressures of each trachea were recorded in Experi-

ment 8 (Fig. 7). In Experiments 9, 10 and 11, (Fig. 8*a*, *b*, *c*) the tracheas were mounted in series and their positions changed in such manner that each of the three in turn occupied all three positions and was connected in turn to all three manometers. The curves obtained are not as striking as in the previous experiments. One reason for this might be that the tracheas were completely immersed in Ringer's solution after removal from the hen. The resulting change in the mucus blanket may have reduced the effectiveness of the ciliary action. The lapse of time from the killing of the hens until the start of Experiment 11 was over three hours. During this period, the ciliary power went down progressively. In any case, the trachea in the number one position (connected to Manometer 1) always showed the lowest pressure and the trachea in the number three position always showed the highest pressure.

CONCLUSIONS

1. The negative pressure produced in the frontal sinus of an anesthetized dog by injecting mucus is not due to absorption of the contained air by the blood stream, but to ciliary action.

2. The effect of ciliary action upon occluding masses or pistons of mucus within a tube such as a hen's trachea is cumulative. That is, several pistons of mucus acted upon by cilia increase the pressure above that produced by one. Each added piston increases the total pressure produced.

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LXI

"POSTNASAL DRIP"

THE CURRENT AMERICAN NIGHTMARE

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To the most recent of those repulsive minor medical bugbears with which the American public delights in saddling itself, it has given an equally repulsive name: "postnasal drip."

The term leaves nothing to the imagination. The symptom, on the contrary, leaves everything, which constitutes its chief menace. It brings up the rear of quite a procession of fearsome public enemies: halitosis; barber's itch; pyorrhea; "strep." throat; "athlete's" foot; and some others.

Where the term arose I am unable to discover. Overnight the laity taught it to the doctors in hushed and often despondent tones. One hears it a dozen times a day, stigmatized usually with one of those clichés reserved for incurable diseases.

Only the term is new. The symptom is ancient. Our grandfathers called it "catarrh"; their grandfathers called it "defluxation."[1] Before that it was a "rheum." One Thomas Cogan states in his "Haven of Health" (London, 1596) that: "There is not any one more annoyance to the health of men's bodies in this realme of Englande, than distillations from the head, commonly called rumes, the occasion whereof some impute to much drinking of Beere, but I thinke the great moisture of the aire of this Realme, for we have a raynie and cloudie skie (as Iulius Agricola saith), and the continuall gourmandise and daily feeding on sundrie meates at one meale, is the very cause why Englishmen be so rhumatike above other nations..."

And so on.

Because patients of all walks of life and levels of intelligence have lately elevated a disagreeable symptom to a serious affliction and come in numbers for relief, one is prompted to consider the nature of these postnasal discharges and to rationalize their causes and effects.

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Actually only one type of discharge is capable of endangering health and that is one carrying virulent organisms. Among the many cases examined this type is relatively infrequent. It should be pointed out that it is the function of nasal mucus to carry off pathogenic organisms and that in these cases the postnasal "drip" complained of is evidence of protective activity, cessation of which would augment the seriousness of the nasal infection.

Patients become conscious of discharge in the nasopharynx when the mucus which is normally there is

1. Excessive
2. Abnormally viscous
3. Abnormally fluid
4. Irritating (mechanically or chemically or biochemically)
5. Odorous
6. Obstructive.

Among the agents capable of bringing about these abnormal states are

1. Central heating
2. Tobacco smoking
3. Alcohol
4. Thermal changes
5. Local mechanical abnormalities
6. Non-malignant lesions
7. Dusts
8. Fumes
9. Bacteria and viruses
10. Fungi
11. Allergens—inhaled or ingested
12. Atrophy
13. Foreign bodies
14. Malignancies
15. Metabolic upsets and eliminative disturbances
16. Endocrine disturbances
17. Emotional disturbances
18. Excessive and prolonged medication.

It will be seen that of the six conditions enumerated above only one (the fourth) is per se a menace to health in some degree. Infected secretions, carried to the stomach or to the lung, presumably cause trouble, and this seems to be the conception which distresses the layman. He often adds to his discomfort by coughing, hawking and in other ways attempting to keep the "poison" from going down and thus sets up irritations which he attributes to the "drip" and which add likewise to the difficulties of diagnosis.

Let us see what evidence there is to support the notion that swallowing nasal secretion is harmful. Nasal mucus is composed of mucin 2.5 to 3 per cent, salts 1 to 2 per cent and water 95 to 97 per cent.[2]

It is more viscous than gastric mucus; nasal secretion containing 1.26 per cent protein has a viscosity comparable to an 8.4 per cent secretion of gastric mucin. Tweedie[3] found the pH of nasal secretion to vary between 6.8 and 7.4 and also in the majority of cases to have a nonculturable bacterial content. "Cases of acute rhinitis up to three days old vary in reaction from neutral to alkaline, but show no culturable content." After this the reaction is alkaline and cultures can be obtained but on recovery the reaction returns to neutral and culturable contents disappear. "In cases of chronic rhinitis without other general symptoms the reaction is usually neutral and the mucus more often sterile than not. In cases of chronic rhinitis associated with sinusitis and polyp formation the reaction may be either neutral or alkaline and there is a culturable content in about half the cases, and *on a medium with a reaction usually responding to that of mucus.*" [My italics.]

Growth of nasal bacteria, then, in the average stomach contents (pH circa 3.6) is problematical and unlikely. "The percentage of hydrochloric acid in the gastric juice is considerably above that at which many organisms can live."[4] If the added mucus has any effect at all it will probably slightly buffer the hydrochloric acid. This is the studied opinion of more than one gastrologist whom I have consulted.

From this it appears that only a deranged stomach in which the pH was approximately that of the nasal secretion could be much affected by nasal secretions, and then only if the secretions contained virulent pathogenic organisms, such as are rather more characteristic of an acute upper respiratory infection than a chronic "postnasal drip."

Let us examine likewise the possible effect of postnasal drainage on the lower respiratory tract. It is well known: 1) that cilia function even in the presence of all but the most acute infections—infections so severe as to destroy epithelium; 2) that cilia in the nose carry secretions back into the pharynx only to the middle of the pharyngeal tonsil, where they are picked up by the muscles of deglutition; 3) that the bronchi are covered with cilia from the upper end of the trachea to the last and least bronchiole and that the movement is consistently toward the larynx where it spills over normally without the necessity of coughing or whence under abnormal conditions it is coughed up into the hypopharynx.

Here again, then, nasal mucus can remain in the trachea, bronchi and lung only in cases in which the ciliary mechanism is incapacitated. These cases are uncommon. They are confined chiefly to such

inflammatory conditions as acute tracheobronchitis or such mechanical ones as bronchiectasis—which brings us face to face with another expressive but vulgar and frequently misleading term "sinus lung."

Presumably this term implies that an infected sinus infects a lung and keeps it infected. No one will deny that an acute upper respiratory infection can and does travel to and infect the lung. But it does not follow that, once the acute stage has merged into a chronic one, the nasal discharge—now fairly innocuous—is responsible for the failure of the chronic bronchitis to clear up. By this time the bronchial tree is infected on its own. Eradicating the nasal discharge alone will not clear up the lung. Our neighbor's dandelions may invade our lawn, but exterminating his will not get rid of ours. Though attempts to cure the bronchitis will be greatly hampered by neglecting the infection above, this applies to any infection—tonsils, adenoids, teeth—and the role played by the lymphatics cannot be overlooked.

Therefore, while the two are co-existent, it is only in special and relatively infrequent cases that a "postnasal drip" is the determining feature of a lower respiratory infection.

Between the upper and the lower respiratory tracts, the larynx bears the brunt of both their discharges, especially at night when unconsciousness permits the accumulation of secretion, and uninterrupted breathing dries it and makes it sticky. Irritation caused by the presence of any type of viscous secretion and the effort of dislodging it is a common complaint.

To return to the clinical problem and the 18 causes of "postnasal drip":

1. *Central Heating.* Low relative humidity in heated rooms results in abnormal evaporation of water from the nasal mucus. Its viscosity increases and the embarrassed ciliary apparatus permits it to accumulate.

This "drip" is a mechanical nuisance, but harmless.

2. *Tobacco Smoking.* The products of combustion from burning tobacco irritate the mucosa, which defends itself by throwing off excessive quantities of mucus. After long indulgence hyperemia gives way to more permanent vascular changes, and the character of the nasal mucus is altered. In some cases the amount is reduced. The subject becomes conscious of his nasal secretion, which in this case is a reaction to irritation and not in itself injurious.

3. *Alcohol.* The ingestion of alcohol is followed by dilatation of the peripheral blood vessels. Owing to their anatomical arrangement the nasal vessels are especially reactive. In many subjects, notably in allergic individuals, the reaction is sufficient to shut off the nasal airways. Sinus ostia are closed. Mucus accumulates in the sinuses, which appears in ropes or globules when they re-open. Usually this occurs on the following morning when the patient no longer attributes it to his drinking. This discharge, like the last, is only the end result of self-imposed conditions and is, in itself, harmless.

4. *Thermal Changes.* In fall and winter (and since the advent of air-conditioning in summer as well) one is exposed to abrupt and often extreme changes in temperature which may occur several times a day. These produce vascular responses in the mucosa of the nose and pharynx which in turn are accompanied by changes in the amount and character of the secretion.[5-8]

Infra-red rays are reported to have a congesting effect on the mucosa.[9]

The patient is conscious of the changes in character and amount of the secretion which accumulates in his pharynx, but these are part of a physiological reflex and are harmless.

5. and 6. *Local Mechanical Abnormalities and Non-malignant Lesions.* These produce changes in the nasal secretions by setting up abnormal air jets and eddies, thus diverting the normal air stream and concentrating it upon restricted areas. The drying effect is the same as under *1.* except that it is localized instead of general.

7. and 8. *Dusts and Fumes.* The dusts of the home and the highway as well as the industrial dusts of mines, quarries and factories which are filtered from the air by the nose are naturally deposited upon the blanket of mucus which coats it. So long as these are chemically inert very little change is produced in the mucus carrying them off. When they are irritating they cause an increase in the secretion at first, which after a time subsides owing to venous stasis, but the mucus becomes more viscous and either sticky or ropy depending upon the amount secreted.

Fumes act in much the same way. Many persons, unaccustomed to the factory environment into which they were projected by the war have reported increased postnasal drainage and pharyngeal discomfort. The secretion is part of nature's attempt to rid the respiratory tract of irritants. In this case the mucus, carrying irritants, may be a menance to health when swallowed.

9. and 10. *Bacteria, Viruses, and Fungi.* The secretions bearing these living organisms may be a danger, as has been stated, by causing, spreading or maintaining infection in the respiratory tract, the digestive tract or almost anywhere else that infection can reach. In order to do damage the organisms must be viable, pathogenic and at least moderately virulent. This and the above constitute practically the only types of postnasal "drip" injurious to health.

11. *Allergens—Inhaled or Ingested.* Under this heading fall the copious watery secretions of hay fever, which are rarely complained of as postnasal, and also the heavier types which, especially when they issue from the sinuses, are apt to be ropy. They are especially troublesome in polypoid noses and are usually present in asthma. They are apt to be found clinging to the nasopharyngeal walls or the posterior margin of the septum.

12. *Atrophy.* Whether it be the specific atrophic rhinitis or the mucosal atrophy which is the terminal stage of a long-standing fibrosis, the airways of the nose are increased and many of the glands are destroyed. To the altered secretions are added desquamated epithelium and, especially in the first mentioned type, other products of degeneration. In this case the disagreeable postnasal discharge is accompanied by crusting and frequently ozena.

13. *Foreign Bodies.* These, principally in children, and rhinoliths in later life are characterized by a unilateral nasal discharge, usually foul and purulent. When there is obstruction, which is common, there is a purulent postnasal discharge.

14. *Malignancies.* The first sign of a nasal cancer is usually an offensive discharge—purulent or bloody. It often makes itself known even before obstruction occurs and is posterior until obstruction sends it forward. It is an effect and not a cause of trouble.

15. *Metabolic and Eliminative Disturbances.* These are common causes of altered and augmented nasal secretion, sometimes directly, sometimes as a result of circulatory congestion. Diabetes and nephritis, colitis of various types and constipation fall in this category.

16. *Endocrine Disturbances.* Among the endocrine disturbances hypothyroidism is by far the most frequent cause of nasal discharge. Changes in the hair and skin find a parallel in the nasal mucosa which is boggy and covered with viscous mucus. The menopause is sometimes characterized by very disagreeable postnasal discharge. This is usually scant but has a bitter taste of which the patient is

acutely conscious day and night. It is often accompanied by some parageusia or glossodynia, or both.

17. *Emotional Disturbances.* Emotional disturbances, fear and protracted anxiety, have been observed on several occasions during the recent war to have produced dry pharynges and altered secretion. These are apparently related to the laryngeal neuroses, dysphagia and aphonia. They usually disappear abruptly with an improvement in the causative circumstances.

18. *Excessive and Prolonged Medication.* Perhaps this category should not be left for last since it is one of the commonest. The regrettable practice of continuing indefinitely the doctor's prescription—intended for a passing ailment—keeps many a nose in trouble. Sometimes it is the drug itself. The constrictors come first because they open the nose; cocaine heads the list. The very opening which the patient seeks causes over-ventilation and drying. The secondary reaction of vasodilatation characteristic of most constrictors causes passive congestion and altered secretion. Sometimes it is a preservative in the mixture which causes irritation and inflammation; among these phenol, menthol, eucalyptol and above all chloro-butenol are the offenders.

This type of "drip" is self-imposed.

CONCLUSIONS

Postnasal discharge, commonly regarded with apprehension, is usually harmless and the result of conditions of modern living, some of which are irremediable.

It is sometimes a physiological response to irritants which it mitigates or removes.

It is a nuisance which should be overcome if possible by removing its causes.

Directing treatment to the sinuses will often fail because the cause lies elsewhere.

If the cause has been determined and found to be uncontrolable the patient can be relieved of much of his distress by rationalizing the situation for him and removing his fear of the consequences.

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LXII

NASAL PSYCHOSOMATIC SYNDROMES ACCOMPANYING AND FOLLOWING ACUTE ANXIETY

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ARMY AIR FORCES

Members of Army Air Forces' combat crews very frequently develop signs and symptoms of disturbances within the nasal passages. Variously diagnosed as aerial sinusitis or otitis and as allergic phenomena, the primary disturbances and the secondary infections cause the flight surgeon great difficulty in his search for their etiology and in their treatment. Differential diagnosis is especially difficult in flying personnel who are exposed for long periods of time to external provocative agents such as extremes of cold, rapid changes of altitude, oxygen masks and dust. However, Grinker and Spiegel[1] demonstrated that these upper respiratory symptoms were most frequently psychosomatic manifestations of acute anxiety, often not consciously apparent to its victim.

This study of the nasal sequelae and concomitants of combat-induced anxiety was made at the Don Ce-Sar Convalescent Hospital at which only combat veteran airmen were hospitalized for operational fatigue (anxiety reactions) after their return to the United States. Among these patients with war neuroses, diagnoses of hyperesthetic rhinitis, nasal blocking and their results were frequently made on admission. The patients were re-examined during the eight to ten weeks of their hospitalization and before discharge and the effect of psychotherapy on the nasal signs and symptoms was followed. For the purposes of this report, the psychodynamics and psychotherapy are not discussed in detail.

The usual nasal symptoms or complaints were hyperesthetic rhinitis, nasal block, eustachian block, and headache. Hyperesthetic rhinitis, nasal block and headache were frequently found in the same patient. However, headaches were only occasionally caused by intranasal pressure, because simple shrinking of the swollen nasal mucosa did not relieve the symptom. In the case reports to follow, the connection between headache and nasal block will always be noted if the headache is not a primary psychiatric symptom of tension.

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If the nose serves as the primary air-conditioning system, functioning to protect the lungs, it should be expected to partake in the general homeostatic adaptation to environmental changes and bodily needs. The two most important of these adjustments are reflected in the size of the air passages, through variation of the volume of the turbinates, and in the quantity of mucus, for the purpose of protection against dryness and inflammation by filtering and moistening the air which enters the lungs. The control of the turbinates is described by Proetz,[2] who states that their volume is altered by the smooth muscle tissue distributed about arterial and venous tracts in the nasal turbinates and in the walls of the spaces of erectile tissue. These structures are innervated by sympathetic fibers from the superior cervical ganglion passing through the sphenoidal ganglion.[3] Epinephrine and other sympathomimetic drugs cause constriction of this smooth muscle, thus emptying the tissue and enlarging the air passage.

Proetz states that exercise, sudden noises or pain will also bring about constriction. From the apparent function of this nasal tissue, such a reaction would be expected from these noxious stimuli. They alert the body for action during which an increased oxygen intake is anticipated, a greater nasal passage is needed and increased mucus is necessary to moisten the added air volume. Patients suffering anxiety reactions long after leaving combat feel consciously or unconsciously as if they were still in dangerous situations calling for actions or alerting for action. Some are so conditioned that a complicated train of sympathetic activity can be set off by the slightest external stimulus, or by an unconscious interpretation of a dangerous meaning to innocuous stimuli. It is characteristic of the most severe states of war neuroses that the patient's ability to discriminate between the reality of "safety now" and the memory of "danger in the past" is lost.

Miller[4] states that a constant discharge of constrictor substances maintains the tonus of the vascular bed. My clinical observations indicate that a relaxation of this tonus occurs immediately after the acute adrenergic stimulus of an anxiety reaction is past. This vasorelaxation, which allows turbinate congestion, may be due to a negative sympathetic state or the result of parasympathetic excitation. In accord with the former view, Jones[3] states that total section of the cervical sympathetic chain causes complete nasal blocking. Fowler[5] reported cases of nasal blocking following central sympathetic injury or section, accompanied by hyperesthetic rhinitis. The presence of basic negative sympathetic states with acute flares of adren-

ergic stimulation in the anxiety reaction is compatible with the repeated toxicity to ergotamine tartrate found by Grinker and Spivey.[8]

On the other hand, Soskin and Bernheimer[7] and Henner and Bushey[8] demonstrated increased turbinate volume with the use of prostigmin, a parasympathetic stimulant. Further, Miller considers that penile erection is the result of parasympathetic stimulation and it is well known that the nasal turbinate erectile tissue and the penile tissues are similar.

Nasal Blocking. Nasal blocking is a common condition, occurring so frequently on the down side of the nose during the relaxation of sleep that it can almost be considered a normal occurrence, especially in the young. It is well known to occur after a person exercises in the cold and subsequently sits quietly in a warm room. It has frequently been described in an acute form after alcoholic indulgence. These facts support the relaxation theory of turbinate congestion. The occurrence of the symptoms of nasal blocking or of over-secretion gives rise in the patient to a series of self-diagnoses, which may become secondary sources of increased anxiety. For nasal blocking, the most common presenting complaint, is "sinusitis." Other frequent complaints are "stuffiness in the ears" or "fluttering in the ears." Less frequently, a sensation of tightness in the head is called "headache." On closer questioning, however, the absence of true pain or ache is readily admitted.

In the cases to be presented, nasal blocking and emotional exhaustion have occurred together. The fact that turbinate congestion and other psychosomatic symptoms have been relieved by acute anxiety states may be interpreted as supporting evidence of a negative sympathetic tonus. Relief of congestion is also secured by locally applied or ingested ephedrine.

REPORT OF CASES

CASE 1.—A 22-year-old, single, radio operator of a B-25, who had flown 53 combat missions, complained of indigestion, inability to eat in spite of being hungry, irritability, and discouragement. The primary nasal complaint was "sinus trouble," manifested by nasal blocking, excess discharge, and morning headaches. All previous colds had lasted only a few days.

The psychosomatic history revealed that the patient had developed headaches with nasal blocking when he first started flying in heavy ships in training. This disappeared as soon as he became accustomed to the air. On about his twenty-fifth combat mission, he

noticed severe nausea and a desire to defecate on approaching each target. During the return flight, he experienced abdominal cramps. A few missions later, the nasal blocking returned and remained with him throughout the remainder of his combat tour. In spite of these symptoms he completed 53 missions.

At the time of the first examination, there was an excessive amount of hyperesthetic rhinitis, but all laboratory examinations failed to show any remaining purulent infection. Apparently, he had developed an acute purulent infection superimposed on a nasal block, but on admission he had only a hyperesthetic rhinitis. During the course of psychotherapy, he developed sufficient insight to understand that his headaches followed periods of nervous tension. On psychotherapy only, his nasal condition improved steadily until at the end of a month he was called home by an illness of his mother, which apparently was a menopausal disturbance. This greatly disturbed the patient who went home still greatly in need of dependent gratification. On his return to the hospital, the patient's nasal symptoms, his general fatigue, tension, and worry had increased. During the remainder of his stay in the hospital, his anxiety improved considerably and his nasal symptoms improved remarkably.

The appearance of the symptom of nasal blocking was correlated with periods of anxiety in this patient's life. Training in combat ships temporarily brought out the symptom until adaptation was effective. Combat anxiety caused a recrudescence, and later frustration of needed gratification did likewise.

CASE 2.—A 34-year-old gunner flew 30 missions, mostly of eight hours' duration with four to six hours in an oxygen mask. Six months prior to going overseas he developed pain over the precordium, tachycardia, and diarrhea, but no significant physical defects were found at that time. During his tour of combat duty, he had chest pains if overtaxed, but they never incapacitated him. From his first mission, whenever he descended somewhat rapidly, he developed headaches, which were relieved by a few hours' rest, but not by nose drops. He also had feelings of tension and abdominal uneasiness when he approached the target, but these were no worse than average.

In the hospital he had typical anxiety attacks, consisting of internal tension, trembling, and perspiring. Immediately after the peak of this reaction was passed, blocking of the nose developed which was accompanied by a dull bifrontal headache. Such headaches could also be brought on by exposure to heat or by exercise.

There was no evidence of purulent sinusitis. The patient was given no local therapy except occasional shrinking of the nasal membranes, which usually brought relief from the headache and the congestion. Under psychotherapy, there was a steady improvement in his symptoms paralleling the loss of his anxiety state.

This case demonstrates nasal blocking in the after-phase of a tension reaction in a person who showed psychosomatic evidences of anxiety prior to combat. But he got along well except for a minimal amount of nasal congestion developing after every mission. Under rest and psychotherapy, the anxiety reaction was relieved and there was simultaneous improvement in the symptoms of nasal blocking and headache.

CASE 3.—A 39-year-old staff sergeant was examined because of a self-diagnosis of sinusitis. There was no infection but a complete right-sided nasal turbinate block which involved the eustachian orifice, reducing the auditory acuity to whispered voice at 12 feet. Immediately after thoroughly shrinking the tissue, the whispered voice was heard at 20 feet. As a result of psychotherapy the severe nasal block disappeared and the hearing returned to normal.

This case illustrates the effect of mucosal congestion induced by anxiety on the eustachian tube and secondarily on the disturbance in hearing.

CASE 4.—This patient is presented because of the development of nasal mucosal congestion simultaneous with the onset of anxiety and to illustrate the occurrence of secondary mild aero-sinusitis and aero-otitis. The relationship to anxiety apparently was not clearly recognized because the patient entered the hospital for re-examination of the eustachian orifices and institution of radiation therapy. On admission, most of his symptoms had disappeared. However, after residual mild spells of tension, he had occasional stoppage of the nose and headaches similar, though milder, to his "aero-sinusitis."

Prior to overseas service, the soldier had no ear symptoms, aero-sinusitis, or tendency for the nose to block. He, furthermore, had no difficulty with rapid airplane descents until after his thirty-seventh combat mission. From this time he noticed the usual physical concomitant symptoms of anxiety. Coincident with these he had difficulty clearing his ears after a rapid descent. At the same time the patient probably had frontal and ethmoid aero-sinusitis, because he developed frontal and temporal headache during rapid descent. These symptoms never appeared until after "bombs away," or until

the plane was safe from fighter opposition. Thus, nasal blocking only occurred after action, in the phase of relaxation. As the patient's fatigue increased, his nasal symptoms grew worse. During his overseas furlough at home and on admission to the hospital, he found that minor stimuli evoked a startle reaction followed by the sensation of tiredness, blocking of the ears and stuffiness of the nose, accompanied by frontal and temporal headaches in all respects similar to those which he had had after the bomb-run. These symptoms rapidly improved under psychotherapy so that on return to duty he had no nose block or ear block, and his eustachian tubes could be easily self-insufflated.

CASE 5.—An extremely passive, dependent aerial gunner had previously developed anxiety on attempts to make mature life adjustments. About one year prior to admission to the hospital, while in combat, he began to have complaints of flatulence and tightness in the head. Later he developed hot flashes followed by excessive perspiration and a general slowing of his mental processes.

Among the psychosomatic symptoms was a crawling sensation around the left side of the face, running into the temple and into the left ear where it produced a blocking and a sensation as of trickling water. At other times, he described this sensation in the temple as a pain or headache. In addition, he had flatulence and often a sense of oppression in the chest. Shrinking the nasal mucosa in the region of the eustachian orifice partially relieved his head symptoms. Even more striking was the fact that a slight anxiety reaction immediately relieved all the oppression in his chest. His head opened up, his ear symptoms disappeared, the gas began to leave his intestines, he felt able to think more clearly, and he had more physical energy. Thus, like the local application of adrenalin, the adrenergic discharge accompanying an anxiety reaction returned him to a state of well-being. An acute sympathetic discharge evoked by anxiety compensated for a decreased sympathetic tonus. This was especially demonstrated in the nasal passages.

CASE 6.—This extremely anxious, inhibited, dependent personality had prolonged Army service in Iceland. He was examined in the Eye, Ear, Nose and Throat Service because of a complaint of marked blocking of the nose accompanied by headache. After psychotherapy, his somatic symptoms improved. The following incident then occurred: On arising one morning he had nasal block and one ear was "popping." At breakfast a conversation was started about Iceland. This brought on an anxiety reaction consist-

ing of general tension, a very loose bowel movement, local tension in his back described as "vibration in the upper lumbar area," increase in pulse and respiratory rate, and simultaneously all the nasal block, the eustachian block, and the "popping" in the ear disappeared.

CASE 7.—Prior to admission, this patient had been treated at other stations for "hives" that appeared regularly at 5:00 p. m. and 10:00 p. m., lasting from one hour to five minutes. Accompanying the hives, there was always nasal blocking. On admission he showed a very strong positive reaction to 0.1 mg. histamine administered intradermally, which also produced a tightness in the head and nose and the type of weakness that always accompanied the eruption of his angioneurotic edema. On mental concentration, such as when writing a letter, or on mild apprehension when keeping an appointment with the doctor, he had a mild anxiety reaction which was usually followed by the angioneurotic edema.

After prolonged psychotherapy, he noticed improvement in the intensity of his "hives," though there was no change in frequency. The intradermal histamine was only mildly positive at this time. After further psychotherapy all symptoms disappeared, the nasal symptoms simultaneously with the angioneurotic edema.

Hyperesthetic Rhinitis. The following cases show the development of acute hyperesthetic rhinitis during acute anxiety, its recession with diminution of anxiety, its recurrence with more anxiety, and finally a change to chronicity under continued anxiety. They show examples of its occurrence in parallel with other psychosomatic symptomatology of the anxiety state in combat. In all cases hyperesthetic rhinitis persisted until admission to the hospital, and all the patients had negative reactions to tests for allergy. Blood eosinophilia has repeatedly been within normal limits, and nasal secretions have repeatedly shown absence of eosinophiles. X-ray examinations and study of the nasal secretions have proven the absence of active infection, except cases quoted to show the occurrence of secondary infections, which developed after the initial symptoms and receded during hospitalization before the hyperesthetic rhinitis.

CASE 8.—This patient was admitted with a mild, acute, purulent rhinitis, which on disappearance left a continuous mucous discharge. After each combat mission a headache developed over the patient's left frontal and retro-orbital areas. During each combat mission an excessive mucous discharge forced this gunner to clean his mask frequently. Gastric cramps were associated with this. On

return to the ground, he was so "tired he could not move." Here anxiety in combat was accompanied by gastric cramps, headaches, and nasal mucous discharge, followed by extreme fatigue.

CASE 9.—A 20-year-old radio gunner first devoloped symptoms of rhinitis during training, becoming more severe after his combat ship had been delivered and the crew was making shake-down flights. The first symptoms noticed were a "fluttering" of the stomach and almost simultaneously he developed a severe tickling in the throat, following which there would be an excessive secretion from the nose after landing. This would disappear in 24 to 36 hours unless he flew daily, in which case the amount of mucus would steadily increase. On or about his fifteenth combat mission the symptoms became worse. He spontaneously admits that there was an element of fright in the situation with the realization that "here I am up against it." Previously, on his first flight, his oxygen valve froze and he became greatly concerned that he would lose consciousness for lack of oxygen. This reminded him of an incident that occurred three years previous when he had a very severe Ludwig's angina type of infection, during which time his neck and jaw were swollen and he had anxiety about suffocation for a number of days.

When he entered the hospital he complained of frequent attacks of pallor, tenseness, abdominal uneasiness, chest constricture and increased heart beat. At these times his nose and throat were dry and he had a tight blunt feeling in the throat. When these feelings subsided, mucus began to drain from his nose and the throat. X-ray examination and blood count showed no infection. Blood and nasal eosinophilia were normal, thus eliminating active allergy.

CASE 10.—A tense, antagonistic individual spontaneously came to the Ear, Nose and Throat Department for "sinus trouble." During his training period in the California desert, he noticed rhinitis following missions. He at first attributed this to flying conditions in the desert, but later admitted that he had anxiety about flying and that nasal symptoms accompanied the nervous tension. These symptoms increased throughout his combat tour in proportion to physical tiredness and increased markedly after his twentieth mission. However, he flew 40 missions, most of which were from 8 to 14 hours' duration. By the time he finished his twentieth mission he felt physically exhausted most of the time. His nasal symptoms improved markedly during the time he was in this hospital under treatment. This patient was able to connect the occurrence of nasal discharge to the anxiety reaction and of nasal block and headache to the after-

period of relaxation. He further was able to relate the severity of the symptoms to the severity of the physical exhaustion.

CASE 11.—This patient illustrates the confusion easily made between psychosomatic, hyperesthetic rhinitis and true infection. He was a 27-year-old corporal who had 38 months overseas duty in the Pacific. He was classified by the psychiatrist as a rejected, frustrated, rigid, introverted personality, who was basically a neurotic, maladjusted soldier. The nasal history, on admission, was that approximately 12 months previously, he had had sudden sharp pains while washing his hair and after swimming. He was treated for a sinusitis at the time and subsequently, although there is nothing in the history to indicate fever, chills, or sore throat. At his previous hospital admission, a diagnosis of sinusitis was made, based on x-ray evidence of diffuse clouding throughout all sinuses. There was no laboratory study of mucus to confirm this diagnosis. On admission to this hospital there was a sticky, clear, mucoid nasal discharge which gave no predominant bacterial growth, though the symptoms were worse than ever. X-rays showed no evidence of paranasal sinusitis and the mucous eosinophile count was negative. All of his symptoms disappeared in proportion to and paralleling the psychiatric improvement of the patient. At this hospital we were not able to substantiate evidence of a purulent infection in the sinuses, nor from the patient's history or records available were we able to sustantiate that such an infection had ever actually occurred. Certainly, on examination hyperesthetic rhintis was all that remained.

SUMMARY

A brief review is presented of the physiology of the nasal secretion and the reaction of the nasal turbinates. The relationship of stimulation and depression to emotional states is demonstrated. The reaction of the nasal tissue to these emotional states is illustrated in a series of cases of soldiers suffering from acute and chronic anxiety reactions, associated with other psychosomatic symptoms. The nasal reactions are shown to follow the accepted principles of sympathetic control of nasal secretion and turbinate constrictions as follows:

1. Active anxiety with adrenergic stimulation is associated with hyperesthetic rhinitis.

2. The after-phase of acute anxiety causes nasal blocking due to relaxation and turgescence of the erectile tissue within the turbinates.

3. Purulent rhinitis, sinusitis, otitis may be secondary results of such blocking or may be prolonged by these symptoms.

4. The functional activity within the nasal passages is a somatic reflection of the individual's emotional state. It is this state which is the primary object of therapy.

Appreciation is expressed to Lt. Col. Roy R. Grinker for his assistance.

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LXIII

THE USE OF TANTALUM IN RADICAL FRONTAL SINUS SURGERY

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The purpose of this paper is to describe a procedure which, it is hoped, will remove one of the causes for failure in radical surgery of the frontal sinus. In 1942 the author[1] reviewed 190 cases of frontal sinus disease which had been operated on at the Massachusetts Eye and Ear Infirmary between 1931 and 1942. Of 123 cases in which the Lynch operation for chronic infection of the frontal and ethmoid sinuses had been performed, 30.18 per cent had to be reoperated later. At the second operation the following causes for failure were noted:

1. Obstruction of the nasofrontal passage by adhesions.

2. Remnants of the frontal sinus floor which had given rise to undrained infected pockets in the frontal sinus.

3. Incomplete ethmoidectomy, especially failure to remove orbital extensions of the ethmoid.

These findings indicate that the following features of the Lynch operation had not been observed at the first operation:

1. Complete removal of the floor of the frontal sinus.

2. Removal of the spine of the frontal bone.

3. Removal of enough of the ascending process of the superior maxilla to give access to the anterior ethmoid region.

4. Complete ethmoidectomy and opening of the sphenoid sinus for drainage, if the latter is involved.

But even where this technique had been observed, a large number of operations had been failures because of adhesions. The prevention of scar tissue at the site of the nasofrontal duct is difficult

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to obtain. This region is involved in the ethmoidectomy so that the nasofrontal duct is removed as an anatomical structure. The area becomes merely a wide open passage. During the operation this appears to be a very large area but after the wound is closed, the orbital periosteum comes closer to the interfrontal septum and the spine of the frontal bone. If these two surfaces become covered with granulation tissue, a bridge may be formed between them which will block the passage between the sinus and the nasal cavity.

This difficulty is one that has bothered every surgeon and various attempts have been made to obviate it. Rubber drains and tubes and mucous membrane flaps to cover the denuded areas have been tried with varying success. If granulation tissue can be prevented from making contact between the orbital periosteum and the medial wall, these surfaces should in time be covered with a thin, flat, fibrous layer or with mucous membrane growing in from the adjacent untraumatized areas.

In 1943 the author sutured a strip of tantalum foil to the orbital periosteum in such a way that it lay in contact with the periosteum from a point just lateral to the pulley downward and medially into the upper part of the nasal fossa. This procedure has been repeated since then on seven other patients, one of whom had had a bilateral operation. The metal has caused no noticeable reaction of the adjacent tissues. The nasofrontal passage has remained open without any tendency to become occluded. The patients also seem to have no unpleasant sensation of a foreign body. Tantalum foil applied in this way as a flat sheet to keep the surface of the orbital periosteum from contact with the medial wall appeals to the author for the following reasons:

1. Any attempt to restore and reconstruct a nasofrontal duct in the anatomical sense is not indicated as the entire ethmoid labyrinth has been removed.

2. A tube placed in this area would have to be of a temporary nature for treatment only, as the walls of the tube projecting upward into the sinus cavity would also block the drainage, so that fluid within the sinus would have to rise to the top of the tube in order to escape.

3. A flat sheet of foil, on the other hand, lying approximately in the position of the original floor of the sinus would offer no obstruction and would allow all the secretions in the frontal sinus to pass freely over its surface into the nose.

The metal tantalum (Ta) was chosen because it has been shown to be inert in animal tissue and it can be cut and fitted easily, at the time of operation, to the area to be covered. Venable and Stuck,[2] in 1938, discussed the use of metals in the body and found that, up to that time, the only metals which were inert and caused no tissue reaction were stainless steel, vitallium and tantalum. All other metals which had been used caused considerable reaction. They confirmed this by numerous animal and chemical experiments and found that the extent of tissue damage was equivalent to the galvanic action which took place between the tissue and the metal. Apparently tantalum did not exhibit galvanic action. Pudenz,[3] in 1943, implanted tantalum plates in cranial defects of 11 cats. The animals were killed after a period of survival varying from 27 to 318 days. There was no evidence of reaction in any of the animals. He concludes that tantalum is a satisfactory alloplastic material for repair of cranial defects. It has desirable qualities of noncorosiveness, inertness in tissue, nonabsorbability, absence of toxic ingredients and malleability. Pudenz and Odom,[4] in 1942, used tantalum foil to prevent meningocerebral adhesions. In all their experiments there was only a minimal reaction of tissue and other cellular elements. There was no reaction involving small round cells, polymorphonuclear leukocytes or phagocytic cells.

REPORT OF CASES

CASE 1.—A man, 42 years of age, entered the Nose and Throat Service at the Massachusetts Eye and Ear Infirmary in September 1943. Preoperative x-ray films showed a mucocele of the right frontal sinus with marked sclerosis about both frontal sinuses and a perforation through the anterior wall of the right frontal sinus. On October 23, 1943, a radical fronto-ethmoidectomy was done and the lining of the frontal sinus together with the mucocele was removed. As the x-ray showed, there was a small perforation of the anterior wall near the supraorbital ridge. A strip of tantalum foil 1.5 cm. wide and 4 cm. long and .00025 inch in thickness was sutured to the orbital periosteum at about the position of the pulley (Fig. 1). The foil was then carefully placed so that it was in contact with the orbital periosteum and extended medially and downward into the upper part of the nasal fossa. The suture material was .003 inch tantalum wire. The patient has tolerated this metal very well. There have been a few attacks of acute rhinitis but the naso-frontal passage has remained patent and there has been no recurrence of the mucocele.

During the past two years a total of eight patients have been operated on with this technique. It is particularly useful in those

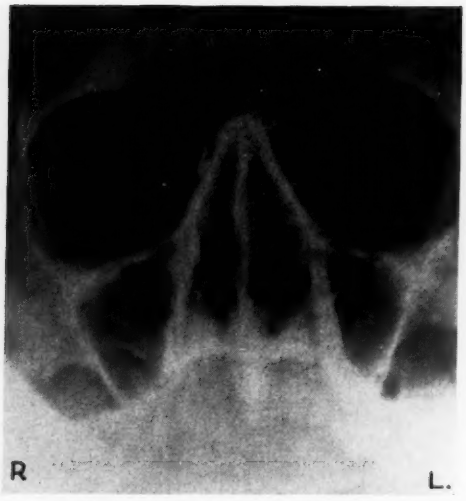

Fig. 1.—Roentgenogram showing tantalum foil in place. This foil is attached at the upper end by tantalum wire to the orbital periostem. The irregular outline is due to the fact that the sheet of tantalum is seen edge on. The foil extends downward through the area formerly occupied by the anterior ethmoid cells into the upper part of the nasal fossa.

cases where the frontal sinus is shallow and where there have been granulations and scar tissue from previous operations. To illustrate this is the following case.

CASE 2.—This was a girl, aged 15, who had had multiple left frontal sinus operations dating from March 1942. Following each operation I attempted to keep the nasofrontal passage open by dilating the duct with a nasofrontal probe. In spite of repeated attempts at regular intervals the passage narrowed until it had completely disappeared. On March 14, 1945 I reoperated and found that there was complete obstruction to drainage due to scar tissue and regeneration of bone near the nasal spine. The obstructing tissue was removed and tantalum foil was employed as in Case 1.

CASE 3.—This case illustrates the same difficulty. This was a patient who was referred to me for revisions of a right frontal sinus Lynch operation. The patient had been operated on for a fistula in an infected right antrum and for right chronic fronto-ethmoiditis.

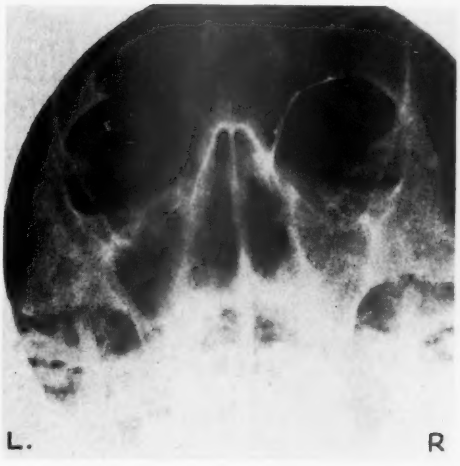

Fig. 2.—The tantalum can be seen approximately in the position of the floor of the right frontal sinus. In this case one suture was placed near the upper end of the sheet of foil and another suture at a point about 1 cm. from the lower end which lies in the upper part of the nasal fossa.

The antrum had cleared up very satisfactorily but the frontal sinus became blocked off by scar tissue. On May 11, 1945, I reopened the right frontal sinus through a Lynch incision. The adhesions were extremely dense and sprang from the region of the frontal spine to the orbital periosteum. The ethmoid was found to be completely exenterated by a previous operation. The sphenoid was entered easily and appeared to be in good condition. There was a little more bone to be taken off the ascending process. The frontal sinus contained mucopus and markedly thickened infected mucous membrane. The floor had been well removed previously. I excised a great deal of organized scar tissue from the orbital periosteum and smoothed off with a curette some rough bone near the frontal spine. Above and below the frontal spine there seemed to be normal mucous membrane which I hope will grow across the bare bone. Tantalum foil was used in this case with the same technique. The patient has had no reaction to the foil and the frontal sinus has remained open.

CASE 4.—This patient was a man, aged 64, who had suffered from right pansinusitis for many years. During the past winter his nostrils had become completely blocked with nasal polypi and he had developed a persistent right frontal headache. In this case a right fronto-ethmoidectomy was performed. A slightly heavier tantalum foil, .0005 inch thick, was used (Fig. 2). His right antrum was not operated upon at this time. It has remained quiescent since the operation. He has a very clear, wide-open nasofrontal passage through which a probe passes easily into the frontal sinus.

In all cases several facts can be noted.

1. These patients are not conscious of any foreign body.

2. In all cases the nasofrontal passage has remained open and there has been a remarkable lack of scar tissue.

3. Although they have had an occasional upper respiratory infection the frontal sinus has not become obstructed and the infection has subsided in a few days.

SUMMARY

A new method is presented for maintenance of drainage from the frontal sinus after frontal sinus surgery where it is definitely unlikely that the nasofrontal passage will remain patent. Eight patients have been operated upon during the past two years with satisfactory results. Four of these cases are reported in this paper to illustrate the technique and indications for its use.

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LXIV

PNEUMOSINUS DILATANS

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AND

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There are various types of pneumatocele of the paranasal sinuses —the pneumatocele externa and the pneumatocele interna. The pneumatocele externa is caused by a defect in the bony wall between a sinus and the skin. Because of this the pneumatocele is concerned only with sinuses which are in contact with the skin; viz., the frontal sinus and occasionally the maxillary sinuses. The defect of the bony wall is usually due to an injury; however, we have observed a case of acute spreading osteomyelitis of the skull presenting an external pneumatocele which was produced by a fistula in the floor of the right frontal sinus. In these instances air escapes into the space between the bone and the periosteum if the defect is only in the bone, or into the subcutaneous tissue if the defect is in both the bone and the periosteum. The internal pneumatocele is the result of a defect in the bony wall between the sinus and the brain. The defect is usually due to an injury and affects particularly the posterior wall of the frontal sinus, occasionally the roof of the ethmoid. In these instances the air escapes into the subarachnoid space or into the brain if the defect is in the dura and the bone.

In addition to the internal and the external pneumatocele, Benjamins[1] described another finding which is characterized by considerable dilatation of the sinus. Since the sinuses are filled with air, he called this finding "pneumosinus dilatans".

The case of Benjamins[1] involves a man, 31 years of age, who complained of pain in the vertex, radiating toward the right part of the forehead, of two months' duration. The pain was marked in the morning and decreased in the afternoon. For four weeks he noticed

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tumors over each eyebrow and a small tumor at the glabella. There was a slight deviation of the septum to the right and small polypi in both middle meatuses, but there was no pus in the nose. X-ray examination revealed the anterior walls of the dilated frontal sinuses to be very thin. The right nasofrontal duct was enlarged by an endonasal operation. Later the right frontal sinus was operated on externally. A part of the anterior wall of the sinus was removed and the thin mucosa exposed. The mucosa did not show respiratory movements. The nasofrontal duct was again obliterated by polypi and was again enlarged.

Other cases quoted by Benjamins are as follows: A case of Meyes involved a man, 18 years of age, who suffered from a chronic purulent ethmoiditis on the right side. Later he complained of headache, pressure and swelling over the right eye. Since the pain increased, the frontal sinus was entered externally. The anterior wall, which was very thin, was removed. The sinus mucosa was normal and the lumen was free of exudate. Following the operation the skin over the frontal sinus bulged when the patient blew his nose. Roepke presented the case of a man, 18 years old, who for two years complained of headache, particularly over the right eye. In the last four months he noticed a swelling over this eye. There was no discharge from the nose, but the middle concha on the right side was markedly enlarged because of a pneumatic cell; the right nasofrontal duct could not be probed. An external operation was performed and when the mucosa was incised, air escaped with a hissing noise. Probing of the nasofrontal duct was not possible from the frontal sinus. Kan cites a case of a man, 50 years of age, with a protrusion of one eye, caused by a tumor in the superior and internal angle of the orbit. The tentative diagnosis was ossifying periostitis or osteoma. An external operation was performed and the anterior wall of the frontal sinus was removed. The nasofrontal duct was displaced; however, it was patent since simultaneously with expiration air entered the sinus. De Cotte and Nove Josserand presented a case of a 12-year-old boy who showed a swelling in the region of the right maxillary sinus. A Luc operation revealed a dilated maxillary sinus which contained air. Van den Helm presented the case of a 15-year-old girl who complained of recurrent protrusion of the left eye. There was no pus in the nose. X-ray examination and operation revealed a pneumatocele of the ethmoid.

To the above cases we can add the findings in the following cases. A patient of Boenninghaus[2] complained of obstruction of the left nostril following an injury of the nose several years ago. The area

of the right frontal sinus was slightly prominent, percussion of this area revealed a dull sound and the right frontal sinus could not be probed. The diagnosis was: Incipient mucocele of the right frontal sinus. Eight years later the prominence over the right frontal sinus was very marked, but percussion of this area revealed now a high sound. X-ray examination showed a large frontal sinus on the right side which contained air. The superior margin of the orbit on the right was lower than on the left side. An external operation was performed and the anterior wall of the frontal sinus removed. The mucosa was normal; the sinus, empty. The nasofrontal duct was very narrow, but could be probed from the frontal sinus. The mucosa of the sinus was removed and the sinus was filled with paraffin. The nasofrontal duct was not enlarged. One year later there was only occasional slight swelling of the forehead.

Zange and Moser[3] report a case of a man, 27 years old, who complained of continuous pressure in the head. An X-ray examination showed a considerable dilatation of the right frontal sinus which was filled with air. The anterior wall of the sinus was thin and the nasofrontal duct was displaced and very narrow. An endonasal operation was performed in order to enlarge the nasofrontal duct. In a case presented by Gruenwald[1] an external operation was performed and the wall of the frontal sinus was found to be thickened. The nasofrontal duct was not found and the air in the frontal sinus was not under increased pressure. A case was presented by Feldman[5] of a man, 24 years of age, who complained of headache and a tumor formation in the area of the right frontal sinus. X-ray films showed a cloudiness of the right maxillary sinus and a dilatation of the right frontal sinus which was filled with air. A Caldwell-Luc operation was performed on the right side. It was found that the sinus was large, but did not contain any fluid, and the connective tissue of the mucosa was sclerotic. Later a Killian operation was performed on the right side. The walls of the frontal sinus were thin, the mucosa bluish, and the nasofrontal duct could not be entered. A new nasofrontal duct was created and the ethmoid and sphenoid sinuses were opened.

A case cited by Greifenstein[6] involved a male patient, 25 years of age, who complained of increasing headache for two years and of nausea and vomiting. For one half year he noticed a swelling above both eyes, which was more marked on the right side. The floor of the frontal sinuses was not bulged. The rhinologic finding was normal and the probe did not enter the frontal sinuses. An external operation was performed on both sides. The mucosa was extremely

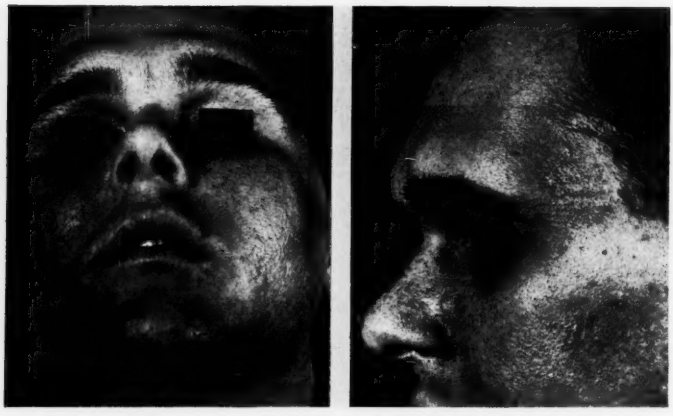
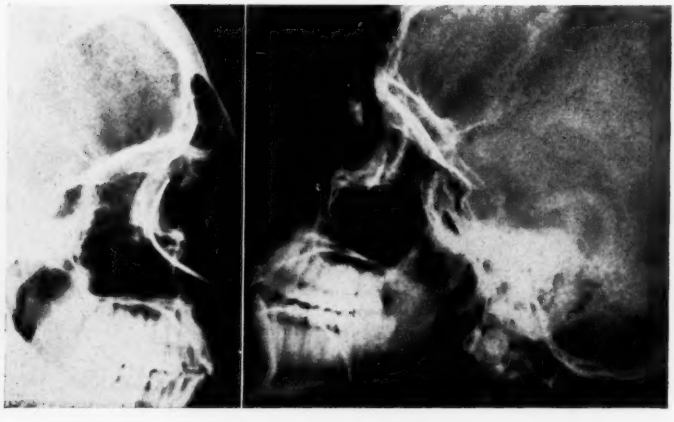


Fig. 1, Case 1—Note the tumors above both eyebrows, the enlargement of the malar bones and the large pores of the skin.



A *B*

Fig. 2, Case 1.—*A* was taken on April 29, 1945. The cannula is introduced into the right nasofrontal duct, but does not enter the sinus. *B* was taken on April 22. Note the dilatation of the frontal sinuses, of the maxillary sinus and the sella turcica.

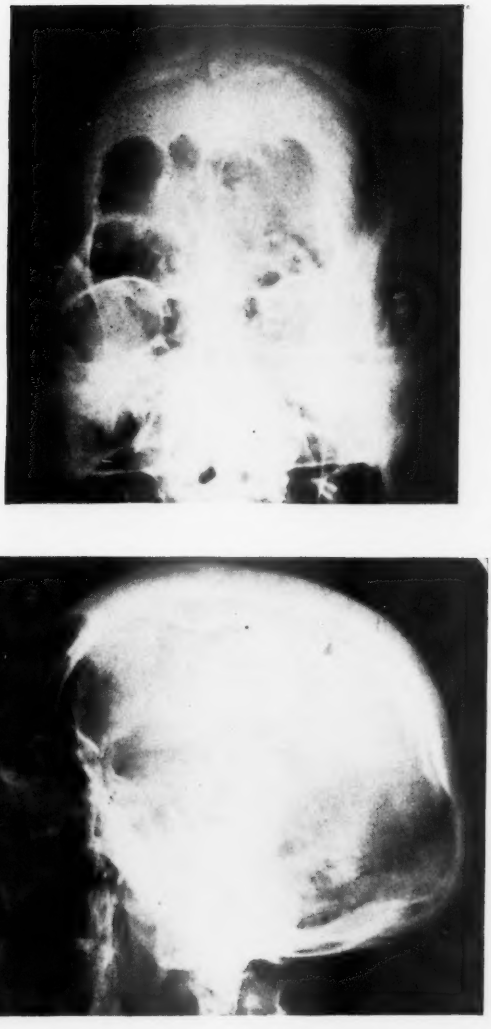


Fig. 3, Case 1.—Roentgenograms showing dilatation of the frontal sinuses. Note the thickening of the occipital squama for the insertion of the muscles of the neck.

thin and there was no fluid in the sinuses. On the right side the probe entered the nasofrontal duct, but could not be pushed into the nose on account of a mucosa bridge which closed the space between the middle turbinate and the lateral wall of the nose. The mucosa was forcefully perforated, the middle turbinate removed and the nasofrontal duct enlarged. On the left side a similar obstacle was created by the middle turbinate, which was deeply embedded in the bone of the lateral wall of the nose. The middle turbinate was removed.

The material of this paper covers the following cases:

CASE 1.—J. F., male, white, 29 years old. About three years ago this patient noticed a swelling above his right eye. In the winter the swelling was more pronounced than in the summer. Occasionally he suffered from slight headache on the right side. More recently he noticed on occasions a redness of the skin over the swelling. There was no history of an injury or nasal discharge. The swelling did not increase when he made a forceful expiration. He was not aware that he had another swelling above the left eyebrow.

On March 10, 1945, spherical swellings were found above each eyebrow, the swelling on the right side being more prominent than on the left (Fig. 1). The floor of the frontal sinus was prominent on both sides and the distance between the cornea and the margins of the superior wall of the orbit was about two cm. The swelling on the right side was covered by reddened skin while the skin on the left side was normal. There was no tenderness and no crepitus. The percussion note was high on both sides but higher on the right. There was a slight deviation of the septum to the left and the tuberculum septi was very prominent on the right side. The right nasofrontal duct could not be entered. The x-ray film showed all sinuses large and clear. The anterior wall of each frontal sinus was prominent and thin; both findings were more marked on the right side. The area of the nasofrontal duct seemed to be pneumatized on the left side, but not on the right. The floor of each frontal sinus was prominent. The sella turcica was essentially normal in size and there was no apparent atrophy of the clinoid processes. There was some tendency to prognathism of the inferior mandible. These findings were somewhat suggestive of acromegalic configuration (Fig. 2B).

On March 31, 1945, under local anesthesia, an incision was made below the right eyebrow; the periosteum was thickened, and the floor of the frontal sinus was exposed and a part of the bone removed. The mucosa was extremely thin and normal and presented marked respiratory motions. A part of the mucosa was removed which

shrunk and curled immediately to such an extent that it could not be kept for microscopic examination. The frontal sinus was empty. The sinus was large, presented numerous incomplete septa and the posterior wall bulged into the lumen of the sinus. The interfrontal septum was perforated; the left frontal sinus was large, empty and the mucosa was normal. The frontal process of the right maxilla was partly removed and the normal mucosa of the agger nasi was exposed. Even then it was not possible to enter the nasofrontal duct from the nose. From the frontal sinus the probe could be pushed into the nasofrontal duct for about .5 cm., but the probe did not enter the nose. The probe was left in place, and the eburnated bone of the enormously thickened frontal process of the maxilla was removed. After this it became possible to force the probe into the nose. The lacrimal bone was not removed. Into the newly created nasofrontal duct a urethral catheter and a strip of gauze were introduced and the external incision was closed.

Two days after surgery there was a slight rise of temperature despite the administration of sulfadiazine, and a swelling of the face extending to the left side. Because of this condition the catheter and the strip of the gauze were removed. The patient then made an uneventful recovery. However, on April 29 the frontal sinuses could not be entered on either side (Fig. 2A) and it was evident that the obstacle was caused by a considerable thickness of the frontal processes of the maxilla which closed the nasofrontal duct almost entirely. The swelling above the right eye had slightly decreased in size. There was no headache, but the patient complained of severe pain in the shoulders and arms. X-ray films of the arms and the shoulders did not show any pathology.

Comment: The case described above is a perfect example of the condition which is referred to as "pneumosinus frontalis dilatans". It demonstrates the slowly growing "tumors" over both eyebrows, the moderate degree of headache, the huge frontal sinuses, the walls of which are thin and do not show any defect, the absence of fluid in the sinuses and the obstruction of the nasofrontal duct. A definite explanation of these findings is not available. Benjamins[1] offered three hypotheses, the first one being that the accumulation of air is caused by gas-forming bacteria. This explanation must be discarded since there is not the slightest finding indicating the presence of gas-forming bacteria. More interesting are the two other hypotheses, the one stating that the pneumosinus is a remnant of a mucocele of the frontal sinus which spontaneously drained into the nose leaving

behind a pneumosinus, and the other stating that the pneumosinus is caused by a partial closure of the nasofrontal duct, as, for example, by a polyp which allows the air to enter the sinus but does not permit its exit. Benjamins himself favors the last hypothesis. But there are findings which render this hypothesis unacceptable. If this hypothesis is correct there would be an increase of pressure in the frontal sinus. This finding was never obtained except in the case presented by Roepke. However, in the case presented above, normal respiratory movements of the mucosa were found indicating that the air entered and left the sinus in the normal manner. For these reasons the valve hypothesis of Benjamins[1] must be rejected. Likewise the second hypothesis is not acceptable. These patients almost never complain of a marked discharge from the nose which would indicate a spontaneous rupture of a mucocele into the nose. Boenninghaus,[2] supporting the mucocele hypothesis, stresses the change of the percussion note over the frontal sinus. He noticed that in his case the percussion note was at first dull and later became clear. From this finding he draws the conclusion that there was primarily a mucocele which later was transformed into a pneumosinus. In our opinion this conclusion is not correct, since the quality of the percussion note depends primarily on the thickness of the anterior wall of the sinus. In our case the percussion note was higher on the right side than on the left, although both sinuses were filled with air. To summarize, there is no satisfactory explanation of the pathogenesis of the pneumosinus frontalis dilatans.

It seems that our case sheds some light upon this peculiar condition. When the patient first presented himself for medical care, we made the diagnosis of pneumosinus and suggested surgery. This suggestion was based on the experience of other rhinologists and on the orthodox teaching of the textbooks. The operation confirmed the diagnosis, but it did not clarify the pathogenesis nor was the result satisfactory. For this reason further studies were made subsequent to the operation. It was recalled that prior to the operation the radiologist had reported "some tendency to prognathism of the inferior mandible. These findings were somewhat suggestive of acromegalic configuration." However, the sella turcica was found to be normal and there were apparently no other conspicuous symptoms pointing to an acromegaly. For this reason we did not evaluate these symptoms properly. After the operation, however, frequent examinations revealed more and more symptoms indicating an acromegaly. The patient was tall and heavy, his skin was rough and had large pores, and his malar bones were prominent (Fig. 1). He complained of severe neuralgic pains in the upper extremities, although the x-ray

examination revealed normal bones and joints. Repeated x-ray examination finally revealed an enlargement of the sella turcica and a partial destruction of the posterior clinoid processes (Fig. 2). Based upon these findings the diagnosis of an adenoma of the hypophysis and incipient acromegaly was made and x-ray treatment of the hypophysis was advised.

Radiologists are well acquainted with the finding of huge paranasal sinuses, particularly frontal sinuses, in acromegaly, while rhinologists are not so well advised of this condition. In these instances the size of the sinuses may reach extreme degrees as shown in Fig. 3, which presents the sinuses in a man, aged 45, suffering from a typical acromegaly. The external ear canals are extremely narrow due to hyperostoses which have hidden the ear drums. The nasal mucosa is normal. The x-ray film (Fig. 3) shows the enormous size of the sinuses, particularly the frontals, while the pneumatization of the mastoids is apparently not increased. In this case the symptoms of acromegaly are very striking while in our case the diagnosis of acromegaly was by no means self-evident. For this reason it must be stated that a dilatation of sinuses might occasionally be a conspicuous symptom of the incipient stage of acromegaly.

The next question to be considered is the mechanism which causes the pneumosinus in acromegaly. The present view concerning the changes of bone in acromegaly indicates that these changes originate (1) in the cartilage which, in the period of body growth, presents an increased proliferation, or, after the termination of body growth, a renewed proliferation, and (2) in the periosteum.[7-8] The proliferation of the cartilage causes a longitudinal growth of the bones while the increase of the activity of the periosteum renders the bones thicker, particularly at the origins and insertions of the muscles. These findings indicate that the skeletal changes in acromegaly are of the nature of true growth which is increased apparently because of the circulation through the body of a substance formed in the pituitary body.

These findings explain the narrowing of the nasofrontal ducts in our case as well as in many cases of this type observed by other physicians. Case 1 proves definitely that the narrowing of the nasofrontal duct was caused by a considerable thickening of the frontal process of the maxilla, which, in turn, was caused by the hyperactivity of the periosteum at this site. This hyperactivity was very marked since a few weeks after the operation the narrowing was again noticeable. However, despite the narrowing of the nasofrontal ducts

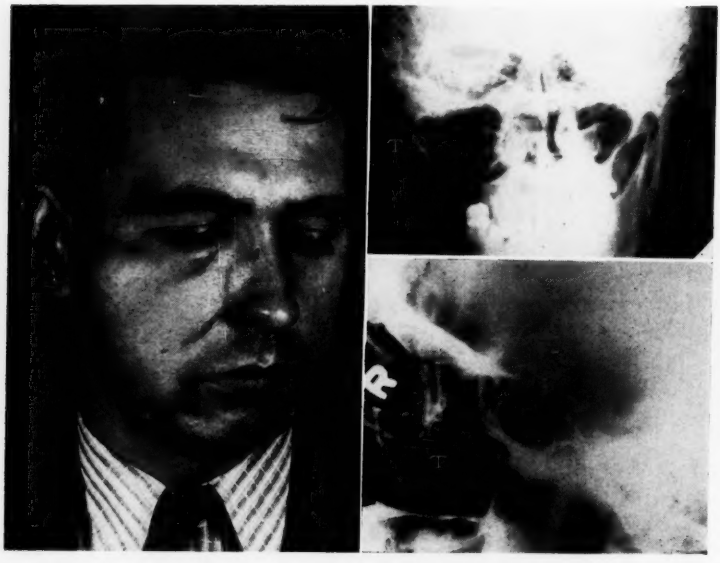


Fig. 4, Case 2.—Tumor in the right malar area.

Fig. 5, Case 2.—Note the dilatation of the right maxillary sinus due to a marked malar recess and the dilatation of the sphenoid sinus. *T*, Tumor; *M*, Mastoid process.

the mucosa of the frontal sinuses presented normal respiratory movements, which proves that even extremely narrow nasofrontal ducts are capable of performing a normal ventilation of the frontal sinuses. Further discussion of the relationship between pneumosinus and acromegaly will be taken up later.

The two following cases present almost identical clinical characteristics:

Case 2.—J. D., male, white, 29 years old. This patient stated that since birth his right cheek bone was enlarged. He never evidenced conspicuous growth of the swelling, but it increased in size in proportion to the body growth. He experienced no pain or discomfort until two years ago, when he noticed that the right ear canal became blocked. The hearing gradually became impaired and at present he is practically deaf on the right side, but without tinnitus or dizziness.

An examination made of this patient on April 20, 1945, showed the right malar bone, particularly the body of the bone, to be replaced by a bone tumor the size of a plum (Fig. 4). The tumor was covered by normal skin and extended to the inferior margin of the right orbit. The right eye was in normal position and did not show any abnormalities. The nose was normal, but there was a chronic tonsillitis. The left ear was normal. The right external ear canal was entirely filled with exostoses which were covered by inflamed skin. Between the exostoses and the posterior wall of the ear canal there was a narrow slit and through this slit a small amount of thin pus escaped. The exostoses seemed to originate from the anterior superior wall of the external canal. The right mastoid was normal and the hearing on the right side was markedly impaired for all tones of the scale, and moderately impaired for the high tones on the left side. An x-ray film showed a marked thickening of the right malar bone. The bone at this site was not eburnized; it consisted rather of spongious bone with narrow spaces of various size between the bone trabeculae. There was a marked expansion of the right maxillary sinus into the malar bone. A similar bulging was noticed on the right sphenoid sinus which extended deeply into the basilar bone. The ethmoids were large, but not conspicuous; the frontal sinuses, the mastoids and the sella turcica were normal. There was no clouding of the sinuses except possibly over the right ethmoid area (Fig. 5).

On May 8, 1945, the external canal was exposed by a retroauricular incision. The exostoses and a great amount of debris were removed. Likewise a part of the anterior wall of the mastoid process was removed in order to enlarge the external canal. The tumor of the malar bone bulged slightly into the canal; it consisted of spongy bone, rich in blood vessels. A part of this tumor was removed and a Thiersch flap was applied to the anterior wall of the mastoid process. After the operation the hearing did not increase markedly, and the external canal was narrow because of the thickening of the anterior wall which bulged into the canal. The drum, in so far as it could be seen, was normal. The calcium content of the blood serum was 11.3 mg. (the normal amount is 9 - 10.5 mg. per 100 cc); the phosphorus content was 3.8 mg. (the normal amount is 4 mg. per 100 cc.)

Microscopic Examination. The bone of the mastoid was normal. The exostoses consisted of a network of bone and connective tissue. The bone was a primitive woven bone which stained red or slightly bluish and contained a great amount of osteocytes. There was no lamellar bone. The connective tissue was very rich in nuclei and in blood vessels and for this reason it was easily distinguished

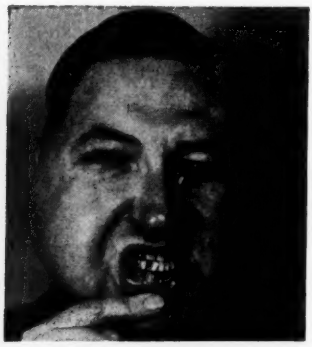
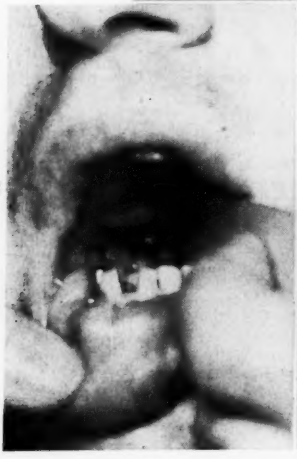


Fig. 6, Case 3.—Tumor of the right malar area. Note the tumor of the lower lip which has caused a displacement of the incisivi.

C



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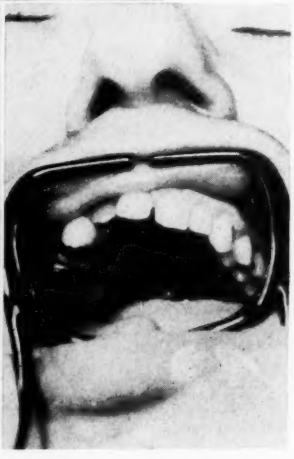

A

Fig. 7, Case 3.—*A* shows the thickness of the upper alveolar process on the right side. *B* shows the multiple tumors of the right cheek and *C* the elephantiasis of the right side of the tongue.

from the connective tissue of the corium of the skin which had a firm texture, was poor in nuclei, was at various sites hyalinized and contained very few blood vessels except beneath the epithelium where a greater amount of capillaries with perivascular infiltration could be found. The bone trabeculae were covered with osteoblasts. There were frequently Howship's lacunae which likewise were covered by osteoblasts while osteoclasts were found within the connective tissue. Many bone trabeculae presented a layer of osteoid. On some sections there was more bone than connective tissue, while on other sections the reverse finding was obtained. In the latter sections a metaplastic ossification within the connective tissue was frequently seen. The exostosis was covered by a thick, scaling epidermis which had a definite tendency to grow into the depth of the corium. However, there were no signs of malignancy. The sections through the tumor of the malar bone showed essentially the same structure as the exostosis.

Diagnosis: Osteitis fibrosa localisata.

CASE 3.—E. B., white, male, 35 years old. This patient's right cheek was enlarged since birth. The enlargement of the cheek grew gradually, corresponding to the growth of the body. He never complained of pain and there was no history of bone fracture. Since childhood he noticed tumors on the mucosa of the right cheek, on the right half of the lower lip and on the right side of the tongue. There were no other tumors on the body and there was no family history of bone disease. The patient was always in good health and was without deformity of the rest of the skeleton. His hearing was diminished on the right side. On June 6, 1927, a linear incision was made along the protruding part of the zygoma by Dr. Mock. Most of the zygoma was removed surgically. A thin shelf of bone was left which was depressed inward. In like manner a part of the infraorbital ridge was removed surgically. Microscopic examination of the bone fragments revealed cancellous tissue with wide trabeculae that enclosed marrow spaces which contained an abundance of hematopoietic tissue. There was absence of tumor in the sections studied. On August 8, 1927, an incision was made along the posterior border of the mandible in front of the ear and continued down to the middle of the horizontal ramus of the jaw. The superficial tissues were dissected backward bluntly, and the excess fat excised. An elliptical portion of skin was excised from the borders of the incision and the two edges brought into apposition by silk sutures.

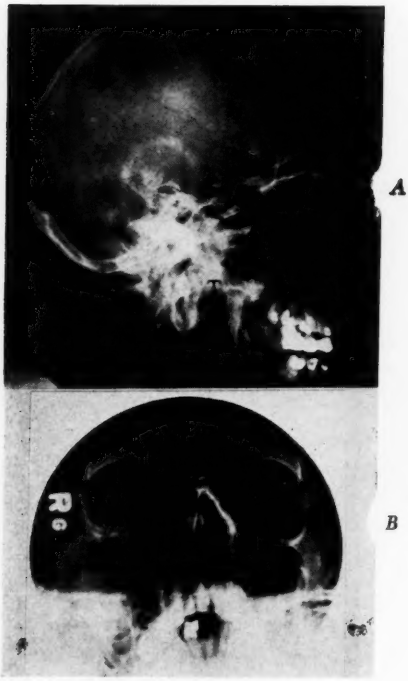

Fig. 8, Case 3.—*A* is taken on June 5, 1945. Note the dilatation of the frontal sinuses and maxillary sinus. *T* indicates the tumor. *B* is taken on June 22. Note the dilatation of the right maxillary sinus due to a marked malar and alveolar recess. *T* indicates the tumor.

On examination May 28, 1945, a considerable enlargement of the right malar bone was found (Fig. 6). The right external auditory canal was obliterated by several exostoses. The skin over the malar bone was normal. There was a scar along the inferior border of the malar bone. There was a thickening of the inferior margin of the right orbit and an enlargement of the right cheek. The alveolar process of the right maxilla was markedly thickened and contained the premolar and two molars, all of which were covered by crowns. The mandible was normal. In the right half of the lower lip there was a tumor, the size of a cherry stone, which apparently caused an abnormal position of the right incisors. There were several

tumors of similar size in the mucosa of the right cheek. All of these had a soft consistency, were covered by a normal mucosa and did not produce any symptoms (Fig. 7). There was a marked elephantiasis of the right half of the tongue. On the left side no abnormalities were found. The nose was normal. There were 10 mg. of calcium per 100 cc. of blood and 3.2 mg. of phosphorus per 100 cc. of blood. X-ray examination revealed that the tumor consisted of a spongious bone with fine pores and involved particularly the body of the malar bone. There was no sclerosis of the bone. The right maxillary sinus was definitely larger than the left and presented a malar recess extending toward the tumor and an alveolar recess extending toward the thickened alveolar process. There were no sharp boundaries between the lumen of the sinus and the tumor, since the tumor apparently extended into the maxillary sinus. The frontal sinuses were very large and the anterior walls protruded and were very thin. The right ethmoid was hazy. The sphenoid sinus and the sella turcica were normal. There was a diminished pneumatization of the right temporal bone (Fig. 8).

Comment: In both cases the most conspicuous finding was the enlargement of the right malar bone which affected particularly the body of the bone and was detected early in childhood. The enlargement increased gradually, in relation to the general growth. On the x-ray film the enlargement consisted of spongious bone, presenting thin and atrophic bone trabeculae which formed a network with narrow meshes. There was no bone sclerosis. In both cases the enlargement of the malar bone was associated with exostoses which caused an obliteration of the external auditory meatus. In Case 2 the exostoses were removed and the microscopic examination revealed a fibrosis of the marrow spaces and a precipitate transformation of the bone; in other words, the typical findings of an osteitis fibrosa. In Case 3 the microscopic examination, which was performed 18 years ago, revealed normal bone. Nevertheless, on the basis of the clinical findings it seems certain that this was likewise a case of osteitis fibrosa. The presence of normal bone does not detract from this diagnosis because it is a well-established fact that osteitis fibrosa advances very slowly and therefore a biopsy may reveal normal bone while close to the site of the specimen taken for the biopsy the bone presents all features of an osteitis fibrosa.

It is difficult to render the diagnosis more exact in these two cases. It is evident that there was not a generalized osteitis fibrosa although an x-ray examination of the entire skeleton was not made. But the absence of deformities and fractures during the long period of illness

and the almost normal findings of calcium and phosphorus in the blood do not permit the diagnosis of von Recklinghausen's disease. But similarly the diagnosis of focal osteitis fibrosa meets with some difficulties. A great number of pathologists state that what is known as "focal osteitis" is in reality the so-called "brown tumors" and the cysts of the bone. X-ray and microscopic examinations did not show brown tumors or cysts in the right malar bones in the cases reported, although it is not known whether these patients might acquire brown tumors or cysts in the future. Presently the enlargement of the malar bone is caused by an osteitis fibrosa. The diagnosis of focal osteitis fibrosa is apparently correct, especially, if in agreement with Pommer, Lang, Looser and others, the term osteitis fibrosa is applied to an unspecific reaction of the bone tissue, which might be caused by stimuli, traumatic, chemical, vasomotor or of unknown origin.

The osteitis fibrosa was more advanced in Case 3 than in Case 2 because the patient was older. Moreover, in Case 3 there was, in addition, a marked thickening of the alveolar processes of the right maxilla, which probably was likewise caused by an osteitis fibrosa, and an elephantiasis which involved the mucosa of the right half of the lower lip, the right cheek and the right side of the tongue. In other words, the elephantiasis involved the same side of the skull as the osteitis fibrosa, while the left side was normal. The elephantiasis of the mucosa consisted of small tumors which were covered by a normal mucosa. Unfortunately biopsy was not possible, but according to the clinical appearance there seemed little doubt that the tumors were fibromas. The elephantiasis of the tongue caused a lobular hypertrophy and, in addition, tumors which frequently had a cone-like shape. The tumors were probably also fibromas, but it cannot be stated whether the lobular hypertrophy was caused by a proliferation of connective or muscular tissue. Fibromas of the tongue and the oral mucosa are frequently caused by neurofibromatosis of von Recklinghausen, especially if they are unilateral.[9] The clinical examination did not, however, reveal a generalized neurofibromatosis and for this reason it seems that, in the case presented, there is a similar relationship between the fibromas of the oral mucosa and generalized neurofibromatosis, as between the osteitis fibrosa of the malar bone and generalized osteitis fibrosa.

The association of osteitis fibrosa and neurofibromatosis is known, although it is by no means frequent. Additional cases of this type were not seen by us, except that one of us had the opportunity to study the relationship between osteitis deformans of Paget and neuro-

fibromatosis.* The osteitis deformans was found in a woman 62 years of age, while her son, aged 37, presented the typical findings of a neurofibromatosis generalisata. However, in all these instances there were systemic diseases, while in Case 3 there was a focal osteitis fibrosa associated with an apparently localized neurofibromatosis.

It is not possible at present to draw general conclusions from these findings, but they should be placed on record so that they may be of assistance in solving the numerous questions associated with osteitis fibrosa and neurofibromatosis.

In osteitis fibrosa the paranasal sinuses, especially the maxillary sinus, are assumed to be obliterated by sclerotic bone.[10, 11] In Cases 2 and 3 the contrary finding was obtained, namely a dilatation of the paranasal sinuses which was particularly marked on the side where the focal osteitis fibrosa was found. In Case 2 there was a marked dilatation of the right maxillary and sphenoid sinuses. Although the maxillary sinus was enlarged in all directions, the principal expansion involved the malar bone. The right sphenoid sinus extended deeply into the basilar bone. For obvious reasons it cannot be stated whether or not there was similar osteitis fibrosa of the basilar bone. In so far as the malar recess of the maxillary sinus is concerned, the x-ray film shows that it is bound by a layer of normal compact bone. This indicates that the maxillary sinus does not simply extend into the pathologic bone of the os malare, but is separated from the latter by a layer of normal bone. In Case 3 the right maxillary was dilated. In the maxillary sinus there was again a marked malar and alveolar recess; in other words, the maxillary sinus extended particularly toward the altered bone. So far as the malar recess is concerned, in Case 3 there was no compact layer of bone separating the air space of the sinus from the pathologic bone.

CASE 4.—J. S., white, male, 29 years of age. When the patient was six years old he was struck by a horse and sustained an injury to the nasal bridge and the right orbital frame. This was followed by a swelling of the right eye and he could not see for two days. Gradually a tumor developed in the inner angle of the right eye. In the spring and fall the tumor seemed to grow causing the right eye to be closed for two or three weeks. In 1936 and 1938 attempts were made to remove the tumor, but in each instance the tumor recurred after a brief period. At the time when the patient was studied, he complained of epiphora and a chronic infection of the right tear sac, and moderate pain as the tumor grew.

*This case was reported by Thalmann.[17]

On admission, September 8, 1940, the motility of the eyes was normal. There was an almond-like tumor, 11 to 12 mm, in the inner angle of the right eye. The tumor was of hard consistency, was covered by atrophic skin with scars. The tumor was above the internal palpebral ligament, the latter being displaced downward; the skin over the tumor was movable, but the tumor was apparently fixed to the underlying bone. When fluid was injected into the inferior canaliculus, it escaped through the superior canaliculus; no fluid entered the nose or the pharynx. The patient said that following the second operation in 1938 air escaped through the eye when he blew his nose; the nasolacrimal duct was probably not entirely closed but only compressed by the tumor in the inner angle of the eye. The reaction of the pupils was normal and so were the fundi. There was a high deviation of the nasal septum to the right; otherwise the nose was normal. The x-ray film showed a marked development of all paranasal sinuses, particularly the left ethmoid. The right ethmoid was likewise enlarged and slightly hazy. The right maxillary sinus was slightly hazy.

On September 10, 1940, an arcuate incision was made in the inner angle of the right eye. The tumor was recognized as a multilocular cyst of dark-blue color, filled with yellowish mucus. There was a shallow groove in the frontal process of the right maxilla caused by the cyst, but there was no communication with the nose. When the periorbit was separated from the lamina papyracea, a spherical bony tumor was found, about 1 cm. behind the anterior lacrimal crista. The tumor was the size of a cherry stone and bulged into the orbit, originating apparently from the lamina papyracea. The tentative diagnosis of osteoma was made and parts of the frontal process of the maxilla, of the lacrimal bone and the lamina papyracea were removed in order to facilitate the extirpation of the "tumor." After the removal of these bones it was found that there was no osteoma. There was rather a marked dilatation of the anterior ethmoid which bulged into the orbit. There was no fluid within the ethmoid cavity and the mucosa was normal. A large opening into the nose was made. A radical removal of the cyst in the inner angle of the eye was no longer advisable because the cyst was firmly attached to the orbital septum. Radical removal of the cyst probably would have caused an opening of the peribulbar and retrobulbar space. Since there was a large communication between the orbit and the nose an infection of these spaces could have ensued. In order to avoid this complication, the cyst was simply incised, displaced into the nose and covered with the mucosa of the agger nasi. The skin was sutured and the ethmoid

drained into the nose. There was an uneventful recovery and the patient remained cured.

Comment: This is a case of dilating pneumatocele of the anterior ethmoid subsequent to an injury of the skull and associated with a multilocular cyst in the inner angle of the eye. The pneumatocele did not cause any clinical symptoms, nor was it recognized on the x-ray picture. The pathogenesis of the pneumatocele cannot be definitely explained; however, the following is a possible explanation:

According to the experiments of Walzer, Fuchs and Salus[12] blunt injuries of the external margins of the orbit usually cause fissures of the lamina papyracea. This occurs even in slight injuries and permits the conclusion that in the case cited the injury might have caused a fissure in the lamina papyracea although the injury was apparently not severe, since the eye was closed only for a period of two days. When the injury occurred the boy was six years old; therefore, the pneumatization of the paranasal sinuses was still in progress. It seems conceivable that in the process of pneumatization the lamina papyracea yielded to the pressure of the air, since the resistance of this wall was diminished by the supposed fracture. Inasmuch as in this case the paranasal sinuses were very well pneumatized and the walls of the sinuses were thin, the yielding of the lamina papyracea can be even better understood. So far as the orbital cyst in the inner angle of the eye is concerned, no definite statement can be made since the wall of the cyst was not examined microscopically. However, it is noteworthy that the cyst recurred after two attempts at removal and it did not recur after the operation of the pneumatocele, although no attempt of a radical extirpation was made. The pathogenesis of the orbital cysts in the inner angle of the eye is not known. Birch-Hirschfeld[13] believes that they originate from a displaced part of the nasal mucosa. The displacement may occur during the embryological development or it may occur after birth, due to an injury. In either case the wall of the cyst is covered by columnar epithelium. The cysts are filled with mucus and blood and have no communication with the nose.

DISCUSSION

The cases reported have two findings in common; (1) In all instances there was a dilatation of the paranasal sinuses which involved the frontal sinuses in Case 1, in Case 2 the right maxillary and sphenoid sinuses, in Case 3 the right maxillary and in Case 4 the anterior ethmoid on the right side. (2) In all instances the walls of the dilated

sinuses were involved by an alteration of the bone, namely, in Case 1 by an acromegaly, in Cases 2 and 3 by a focal osteitis fibrosa and in Case 4 probably by a fracture. These findings permit the conclusion that alterations of the bone, focal as well as systemic, may cause a dilatation of the paranasal sinuses. This statement is somewhat surprising because we are accustomed to expect in alterations of the bone which do not cause vast destruction of the bone, as in syphilis, tuberculosis and malignancies, a narrowing or eventually an obliteration of the sinuses. But an analysis of the reported cases proves that in certain alterations of the bone the sinuses become dilated on account of the bone disease. For this reason the dilatation is found bilaterally when the bone alteration is systemic as in acromegaly, while the dilatation is unilateral when the bone alteration is unilateral, as in focal osteitis fibrosa. This finding is not entirely new. For example there was a case of Schmidt,[14] of a male patient 45 years old, who presented a strictly unilateral gigantism of the skull and the cerebellum although there was no acromegaly. In this case the paranasal sinuses were dilated on the side of the gigantism. The association of dilated sinuses and full-blown acromegaly was frequently emphasized by radiologists and neurologists. But even among the cases of pneumosinus dilatans reported by rhinologists, the presence of skeletal disease is sometimes evident although it is not emphasized by the reporter. For example, in the instance of Greifenstein[6] who presented photographs of his patient, the diagnosis of acromegaly is almost certain, although not mentioned by the author. For all these reasons we believe that pneumosinus dilatans is not a morbid entity, but the symptom of a skeletal alteration which might be focal or systemic in character.

The next question to consider is why some alterations of the bone like osteitis deformans, generalized osteitis fibrosa or leontiasis ossea usually cause an obliteration of the sinuses while other alterations cause the opposite finding. It is so far not possible to offer an entirely satisfactory explanation, but the following factor merits special attention: the time when the bone alteration sets in. If the disease begins at a time when the paranasal sinuses are developed, it may narrow the sinuses provided that the disease is not destructive, but productive, in character. If, however, the bone alteration begins at a time when the sinuses are not yet developed, as it occurred in the cases reported, the result might be an absence or a dilatation of the sinus. The latter finding is obtained in acromegaly, focal osteitis fibrosa and fractures, while, for example, an osteomyelitis usually prevents the formation of a paranasal sinus. The reason why various

bone diseases exert different influences upon the formation of the paranasal sinuses cannot now be answered.

Since the pneumosinus dilatans is none other than a normal sinus which is markedly enlarged, it can be reasonably assumed that the mechanism which causes the formation of the pneumosinus dilatans is not principally different from the mechanisms which cause the formation of the normal sinuses. The conclusions which may be drawn from the cases reported furnish several facts concerning normal pneumatization. Wittmaack[15] has emphasized that the pneumatization of the temporal bone is caused by the activity of the mucosa, the mucosa being the active, the bone the passive part in this process. He admits, however, that the bone likewise may play an active role, but this influence is supposed to be inconspicuous. In the past years the concept of Wittmaack has undergone several modifications. The pupils of Wittmaack[16] have emphasized that the pneumatization is not so much dependent on the activity of the mucosa as on the growth of the bone. Our findings show that the pneumatization of the bones is a more complex act than Wittmaack has assumed and that it is caused by an interplay of the activity of the mucosa, the bone and atmospheric pressure. The cases of pneumosinus dilatans demonstrate the predominant importance of the growth of the bone in the process of pneumatization of the facial bones. At present, it is not yet possible to state exactly all of the factors which allow a larger or smaller expansion of the air space within the bone.

CONCLUSIONS

1. Pneumosinus dilatans is characterized by a marked dilatation, thin walls, normal mucosa of a paranasal sinus and absence of abnormal contents.

2. Pneumosinus dilatans of the frontal sinuses is usually caused by acromegaly and may occasionally be the most conspicuous sympton even in the incipient stage of acromegaly.

3. The narrowing of the nasofrontal duct in acromegaly is caused by a thickening of the frontal process of the maxilla which, in turn, is caused by an increased activity of the periosteum.

4. Even extremely narrow nasofrontal ducts are capable of performing normal ventilation of the frontal sinuses.

5. Focal osteitis fibrosa of the malar bone may cause a dilatation of the maxillary sinus, at least for a long period of time.

6. After injuries of the external margins of the orbit a dilatation of the anterior ethmoid may occur.

7. Alterations of the bone, focal as well as systemic, may cause a dilatation of the paranasal sinuses. For this reason pneumosinus dilatans is not a morbid entity but a symptom of a skeletal disease, which might be focal or systemic in character.

8. The dilatation of the sinuses is found bilaterally when the bone alteration is systemic as in acromegaly, while the dilatation is unilateral when the bone alteration is unilateral as in focal osteitis or after fractures.

9. If the bone alteration begins at a time when the paranasal sinuses are developed, it may narrow the sinuses, provided that the disease is not destructive, but productive, in character, If, however, the bone alteration begins at a time when the sinuses are not yet developed, the result may be an absence or dilatation of the sinus.

10. The normal growth of the facial bones exerts a distinct influence upon the process of pneumatization.

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LXV

TREATMENT OF SUPPURATIVE PARANASAL SINUSITIS WITH REPEATED IRRIGATIONS OF PENICILLIN

A NEGATIVE REPORT

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This report deals with the treatment of suppurative paranasal sinusitis by repeated irrigations with penicillin solution at an army general hospital. This hospital served as a thoracic surgery center. Among its patients were many who had bronchiectasis associated with paranasal sinusitis. The policy of the thoracic surgeons was to resect the infected portions of bronchiectatic lungs in selected cases. As a prerequisite to lobectomy, it was considered desirable to reduce infection in the paranasal sinuses.

Conservatism was the rule in treatment. However, as is common otolaryngologic knowledge, paranasal sinusitis complicating bronchiectasis usually is extensive, chronic, and longstanding. Its response to simple local therapeutic measures is generally unsatisfactory. In most instances surgery was necessary.

Treatment of these chronic sinus infections by repeated penicillin irrigations together with parenteral penicillin injections was carried out. This therapy was not effective. It was abandoned after a small number of patients had been treated. There are certain features about this series which seem to make reporting it worth while. The patients were all young adult males whose general health was good. They should have had an excellent chance for recovery. They were treated in an army hospital where control of the patient was complete. Ample supplies of penicillin were available. In spite of these favorable factors the treatment was successful only in subacute cases. The number of cases in the present series is small only because the treatment proved to be ineffective and was abandoned in favor of older and more generally accepted therapeutic procedures. This experience is being reported so that it can be added to that of others and thus will be of value.

In November 1944, Sales and Diamond[1] described irrigation of the maxillary sinuses of a single patient with penicillin solution

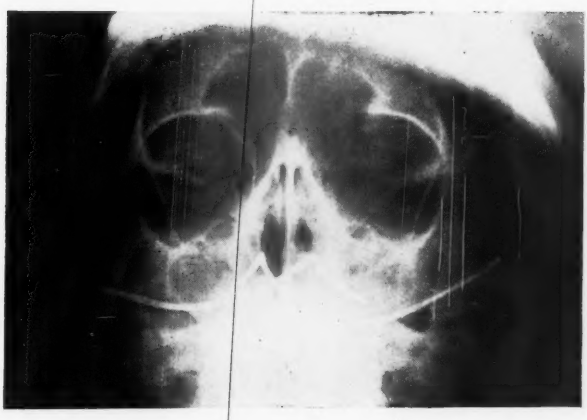

Fig. 1.—Ureteral catheters are shown entering both maxillary sinuses through inferior meatuses.

as a method of treatment of chronic maxillary sinusitis. Their method seemed to be worthy of further trial and was used in a series of patients at Baxter General Hospital in December 1944, and during the early part of 1945. The data on these patients are presented in the report of cases.

Sales and Diamond introduced spinal needles into the maxillary sinuses and kept the needles in place for 24 hours. They administered no penicillin parenterally. Their patient was free from signs of suppurative sinusitis after 15 days and is not reported as having been followed at a later time.

The writer modified the method of Sales and Diamond by:

1. Using indwelling segments of ureteral catheters to conduct the penicillin solution into the antra (Figs. 1 and 2). The flexible catheters were considered safer than the rigid needles for prolonged use. The catheters were introduced through an ordinary antrum cannula inserted via the inferior meatus. The patient's head was placed in the Parkinson[7] position during injection.

2. Administering penicillin parenterally with the intention that the organisms in the infected sinus mucosa would be attacked by penicillin delivered from the blood stream on one side and from the mucosal surface on the other. This seemed feasible in light of the

statement of Crowe and his co-workers that penicillin topically applied had great tissue penetrating power.[2] One hundred thousand to 120,000 units of penicillin were injected intramuscularly in each 24 hour period. Parenteral injections were carried on for 10 to 12 days.

3. Instilling a larger dose of penicillin into each maxillary sinus through the catheter than that given by Sales and Diamond. The writer's patients received 8,000 units every three hours. The length of time that these injections were continued varied from one patient to another, but was finally stabilized at about six days. Sometimes the catheters slipped out, and in the early cases they were removed after shorter periods of time.

Eight patients having suppurative paranasal sinus disease were treated in the manner outlined above. Four had bronchiectasis and four did not. Ten maxillary and two frontal sinuses were repeatedly irrigated with penicillin. Of the ten maxillary sinuses treated, four were improved to the extent that no further treatment was necessary. Two of these maxillary sinuses were those of a patient who had bronchiectasis (Case 2). These two maxillary sinuses were the only ones in the bronchiectatic group which seemed to recover completely and to remain well. In all the rest of the bronchiectatic group, either there was no improvement at all or the infection recurred after a few weeks or months. The other two maxillary sinuses which improved were subacute sinus infections not complicating bronchiectasis (Case 4 and Case 6).

Two frontal sinuses were treated by catheterizing them with short pieces of ureteral catheter and irrigating them in a manner similar to the maxillary sinuses. Both frontal sinuses were those of patients who had severe bronchiectasis (Case 3 and Case 8). Neither one improved. Surgery has been done on one of these sinuses with a satisfactory result. The other frontal sinus has not been operated upon.

Bacteriologic Control. In the penicillin treated cases reported above, in vitro studies of susceptibility of organisms to penicillin were not made. Cultures were taken prior to treatment. Only cases infected by organisms against which penicillin is usually effective were treated. In Cases 5, 7 and 8 mixed infections were present. In addition to organisms against which penicillin was effective, Hemophilus influenzae and Klebsiella pneumoniae were found. These organisms are considered to be insusceptible to penicillin.[10] Patients having mixed infections were treated because one penicillin-sensitive

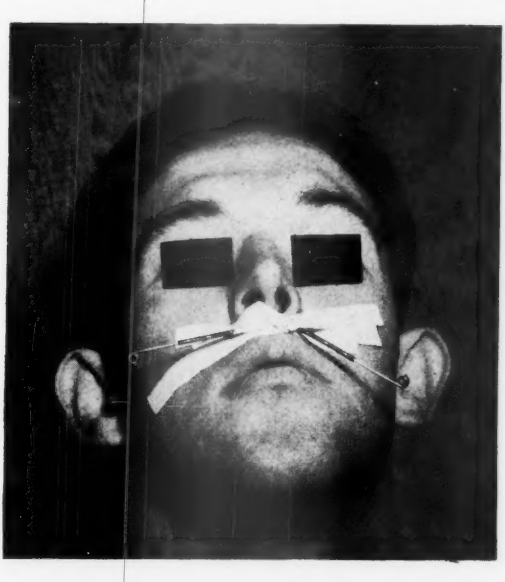

Fig. 2.—Patient with antral catheter in place. Catheters closed by portions of safety pins.

organism was present in large numbers in each case. It was hoped that destruction of this organism might permit the infected sinus mucosa to recover sufficiently to rid itself of the other pathogens. This did not occur in any of the three cases. One must consider that perhaps the failures occurred because of the presence of penicillin-resistant organisms.

REPORT OF CASES

Case 1.

Infection. Right and left maxillary sinusitis which had been previously treated by repeated antrum irrigations.

Bronchiectasis, left lower lobe, severe.

Symptoms. Purulent nasal and postnasal secretion.

Sputum, cough, debility.

Organisms. Hemolytic staphylococci.

Local Treatment. Irrigations through indwelling catheters with penicillin, 8000 units in 4.0 cc. every 4 hours for 24 hours. Total—48,000 units in right maxillary and 96,000 units (48 hours) in left maxillary.

Parenteral Penicillin. 20,000 units intramuscularly every 4 hours for 12 days. Total—1,440,000 units.

Surgical Treatment. Lobectomy, 30 days after nasal treatment cited above was completed.

Results. Complete cessation of nasal discharge and postnasal secretion after 14 days. Recurrence of purulent drainage after 90 days.

Comment. Patient has finally had bilateral Caldwell-Luc type sinusotomies with satisfactory results.

CASE 2.

Infection. Right and left maxillary sinusitis; intranasal antrotomies done at another army general hospital. Previous treatment with sulfathiazole solution instilled into antra.

Bronchiectasis, left lower lobe, severe.

Symptoms. Purulent nasal and postnasal drainage.

Sputum, cough, debility.

Organisms. Hemolytic staphylococci and streptococci.

Local Treatment. Irrigations with penicillin as outlined for Case 1.

Parenteral Penicillin. Parenteral injection in dosage as outlined for Case 1.

Surgical Treatment. Lobectomy 60 days after end of sinus treatment.

Results. Complete cessation of drainage with no residual nasal complaints. Last report: after seven months, no recurrence of symptoms.

Comment. This is the only entirely satisfactory result in the penicillin series in chronic sinusitis coexisting with bronchiectasis.

CASE 3.

Infection. Right and left maxillary sinusitis.

Left ethmoid and frontal sinusitis.

Symptoms. Purulent nasal and postnasal secretion.

Pus flowing from region of left nasofrontal duct.

Organisms. Neisseria catarrhalis.

Local Treatment. Irrigations of antra through indwelling catheters, 8,000 units of penicillin every 4 hours until 176,000 units were given in each antrum.

The left antrum showed improvement but there was a recurrence of severe suppuration three days after penicillin irrigations ceased. Local treatment repeated with no improvement. Right antrum unimproved.

Left frontal sinus cannulated with ureteral catheter and irrigated with 3.0 cc. of penicillin, 2,000 units per cc., every 4 hours for 7 days. No change in suppuration.

Parenteral Penicillin. 120,000 units per 24 hours intramuscularly for 12 days (while antra were being irrigated with penicillin).

120,000 units daily for 7 days (while frontal was being irrigated with penicillin).

Surgical Treatment. Caldwell-Luc type sinusotomy, right.

Left Caldwell-Luc type sinusotomy. The sinus membrane thick and the lumen contained pus, January 2, 1945. Submucous resection of nasal septum and intranasal anterior ethmoidectomy on January 17, 1945.

Left frontal sinus opened through floor and lining curetted out, February 19, 1945. Pus in lumen. Histologic examination of membrane showed chronic inflammation.

Results. Complete cessation of drainage from right antrum after 30 days. Five months later suppuration recurred and was as severe as originally.

Suppuration from left antrum ceased but continued from areas of ethmoid and frontal duct. Seven months later left antrum still free from suppuration.

Smooth postoperative course on frontal sinus. Five months later nasal space is still free from pus.

Comment. Caldwell-Luc type sinusotomy done. Surgical result good.

Patient had left lower lobectomy on March 31, 1945. Nose and sinuses improved markedly after lobectomy.

CASE 4.

Infection. Left maxillary sinusitis, severe, five days' duration. Had lost right eye on Guadalcanal and was in great fear of injury to left eye by infection.

Symptoms. Pain, fever, suppuration left middle meatus; acute myositis, left shoulder, severe. No improvement after five days of conservative treatment.

Organisms. No growth obtained. Culture made after treatment was started.

Local Treatment. On January 30, 1945, 15 days after onset and 10 days after admission, patient had not improved on heat, shrinkage, codeine. Foul pus on irrigation. Indwelling catheter inserted and sinus irrigated with 8,000 units of penicillin every 4 hours for 48 hours.

Parenteral Penicillin. 120,000 units intramuscularly every 3 hours.

Results. Prompt cessation of pain and drainage. Ten days later no recurrence of either. Nose free from pus.

Comment. In this subacute case, response was far superior to any chronic case except Case 2. Penicillin given parenterally alone might have produced a cure here.

CASE 5

Infection. Right maxillary sinusitis, severe, suppurative.

Symptoms. Scarlet fever in September 1944 with sinusitis. Had right antrum window operation October 14, 1944 by another army otolaryngologist. Was much improved but sinusitis recurred and patient was readmitted February 17, 1945. Window patent but much pus in left antrum.

Organisms. Hemolytic streptococci and staphylococci, organisms of hemophilus group.

Local Treatment. Irrigations through indwelling catheter, 48,000 units of penicillin daily for 6 days.

Parenteral Penicillin. 120,000 units intramuscularly for 6 days.

Surgical Treatment. See under results.

Results. Cessation of pus for 8 days; then recurrence of pus and soon was as bad as before treatment. On March 26, 1945, a Caldwell-Luc operation done. By April 10, 1945, patient was well and has remained so. Six months later patient having no further trouble.

Comment. Had orthodox conservative therapy, penicillin locally and parenterally without improvement. Is clinically well after Caldwell-Luc operation. Hemophilus organisms probably caused recurrence here.

CASE 6.

Infection. Sinusitis, maxillary, ethmoidal and frontal, left, chronic, suppurative, severe.

Symptoms. In December 1944 had influenza followed by left maxillary, ethmoid and frontal sinusitis. Admitted to Baxter General Hospital March 3, 1945, with pus in left nasal space and choana.

Organisms. Report not available.

Local Treatment. 48,000 units of penicillin per day by catheter in antrum for 6 days.

Parenteral Penicillin. 100,000 units per day for 12 days.

Surgical Treatment. None.

Results. No pus in nose or antral washing 5 days after discontinuing penicillin. Water returned very slowly as if lining of sinus was thick or ostium small. Fifteen days after discontinuing penicillin patient clinically well and sent back to duty.

Comment. A fairly good clinical result in a case not complicating bronchiectasis. Follow-up inconclusive.

CASE 7.

Infection. Right maxillary sinusitis, severe, incidentally found during treatment of severe recurrent urticaria.

Symptoms. Purulent right nasal and postnasal drainage.

Organisms. Pneumococci, type XVIII, and organisms of hemophilus group and staphylococci.

Local Treatment. 48,000 units of penicillin per 24 hours by antral catheter for 6 days. Total—272,000 units.

Parenteral Penicillin. 20,000 units intramuscularly every 3 hours until 680,000 units given.

Surgical Treatment. See under comment.

Results. Improved but recurred after 10 days.

Comment. Right Caldwell-Luc operation followed by biweekly injection of autogenous vaccine. Improvement in urticaria for 2½ months; then recurrence. Sinusitis much improved.

CASE 8.

Infection. Bronchiectasis. Bilateral maxillary and left frontal sinusitis. Previous treatment included bilateral intranasal antrotomies.

Symptoms. Purulent postnasal drainage, sputum, debility.

Organisms. Friedländer-like organisms, staphylococci.

Local Treatment. Anterior ethmoidectomy. Catheter introduced into left frontal sinus and 6,000 units of penicillin introduced into sinus every 4 hours for 5 days. Antra irrigated as in Case 7. No improvement.

Parenteral Penicillin. 20,000 units intramuscularly every 4 hours for 5 days.

Surgical Treatment. Anterior ethmoidectomy; lobectomy.

Results. Improvement for about one week after irrigation with penicillin; then suppuration recurred but to a lesser degree than before treatment.

Comment. Patient's sinusitis improved by surgical therapy and apparently further improved after lobectomy.

COMMENT

The results of penicillin therapy outlined above are in general agreement with the few reports to be found in the current literature. Crowe, et al,[2, 4, 8, 9] state that results of local application of penicillin to the sinus mucosa will be more favorable in acute than chronic maxillary sinusitis. They hold that the organisms are nearer the surface and therefore are more accessible in acute infections. Hauser and Work[5] reported that long-standing chronic suppurative sinusitis was not cured by penicillin given parenterally. Consideration of Proetz's[6] studies suggests that application of concentrated solutions of penicillin to nasal mucosa, as was done in the cases reported here, may interfere with ciliary activity to a significant degree. Kolmer's[3] hope that the local instillation of penicillin would be of value in treatment of chronic sinusitis was not borne out.

SUMMARY

Eight chronically infected maxillary sinuses were treated by repeatedly irrigating them with penicillin solution. Recovery occurred in only two cases co-existing with bronchiectasis. Two other maxillary sinuses in which the disease was subacute recovered. Satisfactory recovery after a Caldwell-Luc. type sinusotomy has occurred in all but one of the unimproved maxillary sinuses. Recovery after removal of the floor and the infected lining of one of two unimproved frontal sinuses has occurred.

Because of the unsatisfactory experience outlined above, the treatment of long-standing maxillary sinusitis by local irrigation with penicillin has been abandoned. This method may prove to be useful in subacute infection.

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LXVI

PHOTOGRAPHY THROUGH A NASOPHARYNGOSCOPE

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Black and white pictures or color transparencies of the nasopharynx can easily be made through a nasopharyngoscope. The technique is simple and the material required is readily obtainable. The method to be described was evolved from work done in the Irradiation Clinic, Westover Field, Massachusetts. Pictures were desired to illustrate the hyperplasia of lymphoid tissue about the eustachian tube orifices and to show the effects of radium upon this tissue.[1] For teaching purposes, also, such photographs would be a distinct aid.

A 35 mm. camera is the most practical, because of its small size and short focal length lens. An additional advantage is the economy of film, the image produced being only 7 mm. in diameter. Also color film for the 35 mm. camera is readily obtainable. A time exposure must be used; therefore the speed of the lens is not important. The use of a cable release is recommended in order to lessen the jarring effect of tripping the shutter.

Either an older nasopharyngoscope with a 2.5 cm. eyepiece, or a later model with a 3.5 cm. eyepiece may be used. If the lens mount of the camera is less than 3.5 cm. in diameter, the nasopharyngoscope with the smaller eyepiece must be used.

A filter adapter and filter retaining ring, ordinarily used to fasten a color filter over the lens of a camera, are used to attach the nasopharyngoscope to the camera. In place of the filter, however, a thin fiber washer is placed in front and behind the eyepiece; the retaining ring is then tightened and the nasopharyngoscope instead of the color filter is ready to be attached to the camera (Fig. 1).

To insure photographing the exact field desired a wooden rack was devised to provide a solid support for the nasopharyngoscope. The patient lies comfortably on his back on a bed or cot, with his head on a pad or other supporting object, and the rack, which is

From the Irradiation Clinic, 112th Army Air Force Base Unit, Westover Field, Mass.

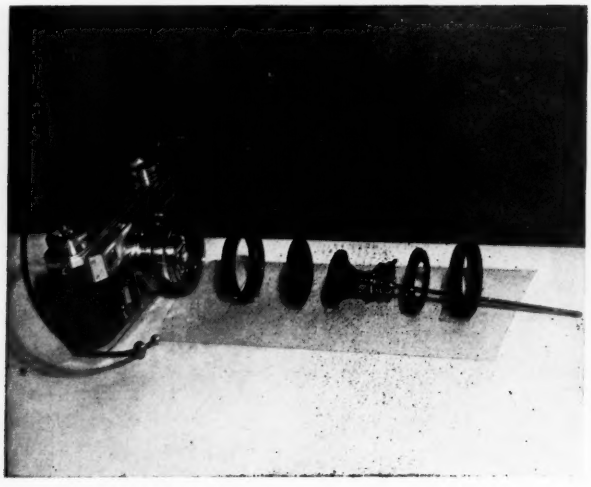

Fig. 1.—From left to right are a 35 mm. camera, filter adapter ring, fiber retaining disk, nasopharyngoscope, fiber retaining disk, and filter retaining ring. When assembled in the order shown the nasopharyngoscope may be attached directly to the lens of the camera.

Fig. 2.—The camera rests in the filter adapter ring while a time exposure is being made.

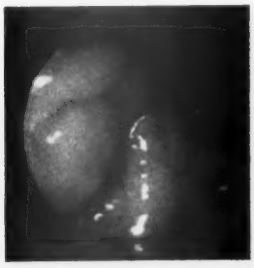

Fig. 3.—View of the left eustachian tube taken from the right side of the nasopharynx. The tubal opening is in the lower left part of the picture. The torus is hidden by large nodular masses of lymphoid tissue which extends from the fossa of Rosenmüller and from the adenoids.

hinged to the wall, swings directly over his head. The rack is adjustable in the vertical plane and a slot in the rack permits the nasopharyngoscope and camera to be move horizontally.

It is important that the inferior meatus be properly anesthetized and that excessive secretions be removed by blowing or suctioning so that the patient is comfortable and the field of vision clear. To hold the breath for a time exposure is difficult; therefore patients are instructed to breathe normally and quietly through the nose, with the lips closed, and not to swallow or try to speak while the photographs are being made. Talking by the patient between pictures also should be avoided, because the lens of the nasopharyngoscope may become blurred with mucus and delay the proceedings.

With the rack over the patient's nose, the nasopharyngoscope is passed through the slot in the rack and then passed along the inferior meatus until the area to be photographed is visualized. The rack is adjusted then to carry the weight of the nasopharyngoscope and is locked in position. The clamp-like prongs of the adapter, if already loosened, make it possible to attach the lens mount without moving the nasopharyngoscope. The camera is then fitted into the adapter and the rack supports them both (Fig. 2). If care is used to select the side of the nose with the least obstruction and if the walls of the inferior meatus have been moderately anesthetized, there should be no discomfort whatever for the patient.

Before attaching the camera to the nasopharyngoscope it should be set for "time" with the lens at the largest stop opening and focused

at "infinity." The camera is placed in the adapter and the cable release pressed for the desired number of seconds. A written record should be kept of the area photographed together with its picture number to enable subsequent identification.

The illumination is furnished by the lamp in the nasopharyngoscope. The brilliance should be checked by a light meter to insure a constant setting for each picture. More brilliance is required for color work in order to obtain correct hues of reds and pinks. This shortens the life of the lamp bulb but with careful testing with a light meter consistent photographic results can be obtained without too much of an overload. (Roughly, one candle power of light suffices for the black and white and 1½ candle power for the color pictures. In our clinic, the light is checked by placing the lighted bulb at the open window (cover open) of a General Electric light meter and adjusting the brilliance until the meter reads 25 for the black and white and 35 for the color pictures).

The length of exposure varies. Color film requires more than black and white. In general, 15 to 18 seconds gave good results for a film with a Weston rating of 100 (black and white) when the light measured 25 at close range and when the nasopharyngoscope was in the right side of the nose when the left side was being photographed (and vice versa). Placing of the nasopharyngoscope through the opposite side gives a larger field of vision and a more satisfactory picture of the eustachian orifice than when taken at closer range. With color film (Weston rating of 12) and the light measuring 35, about 50 to 60 seconds exposure produced good pictures.

Contact prints of the black and white pictures may be made but moderate enlargements such as Fig. 3 seem more desirable. The color pictures may be projected upon a screen or processed into color or black and white prints.

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LXVII

MÉNIÈRE'S SYNDROME: THE VALIDITY OF THE INTRADERMAL HISTAMINE TEST

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In a paper in 1941[1] I made the claim that cases of Ménière's syndrome could be divided into two groups by means of an intradermal test with histamine. I described the test which I used and the criteria by which it was assessed, and maintained then, and have continued to maintain since, that the two groups required different, indeed diametrically opposed, therapy. These claims have lately come under fire from Williams, in a paper on what, as he puts it, he has "chosen to call 'the syndrome of intrinsic allergy' ".[2] In this category he includes four conditions: Ménière's syndrome, vasomotor rhinitis, myalgia and what he calls the vasodilating pain syndrome of the head. As a result of performing a skin test with histamine, according as he believed, though wrongly, to my specifications, on 55 patients conforming to his diagnostic requirements for intrinsic allergy and on 15 patients who gave no such history, he came to the conclusion, among others, that "skin tests with histamine seem valueless both for diagnosis and as a guide to therapy."

This is a serious indictment. If true, it falsifies every claim I have made for the test and all the results I have published based upon it. I have therefore undertaken some investigations to check again on my own method and findings as published and to test the validity of Williams' criticism.

Before describing these investigations, it is necessary to recapitulate some previous work in order to make matters clear.

My original description of the method used by me was that 0.01 mg. of histamine was injected intradermally with a control of the same volume of physiologic solution of sodium chloride. This I recognize to be an entirely inadequate description, and I apologize for it. It was amplified in a later paper[4] but as a result of the original

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inadequacy, Williams assumed that when I mentioned a dose of histamine I referred to histamine base. In fact, not appreciating at that time the importance of calculating dosage in terms of base, I was using 0.01 mg. of histamine dihydrochloride ("Imido" Roche), which is equivalent to only 0.0057 mg. of base, and this dissolved in 0.1 cc. gives a 1:17,544 solution of base. Williams, however, used 0.01 mg. of base in the form of histamine diphosphate, or 0.0043 mg. more of base than I used, and dissolved it in only 0.01 cc. giving a 1:1000 solution of base. He was thus using a considerably larger dose (1.75:1) and a much higher concentration. He says, "It is assumed that this variation could have little effect on the results." It will be seen later what a large effect this variation does in fact produce.

The criteria of normal and abnormal response were determined by trial and error. The description of the abnormal response which was given in my original paper[1] and which I have found no reason to change, is as follows:

"The criteria adopted for a positive reaction were a wide area of erythema, 1½ to 2 inches (3.8 to 5 cm.), a large wheal ½ to ¾ inch (1.3 to 1.9 cm.) and the presence of long trailing pseudopodia an inch or more in length which appear in three to five minutes, begin to fade only after twenty minutes and are still apparent at the end of thirty minutes. Small buds at the edge of the main wheal which fade in ten to twenty minutes are not assessed as positive. In a few doubtful cases, when something more than a bud and less than a true pseudopodium appeared, the intradermal test was repeated, 0.02 mg. being used. This always served satisfactorily to separate the sensitive from the insensitive, since those patients who were truly, even if weakly, sensitive showed a decided increase in reaction, while those truly insensitive did not."

No description of the normal response was given in the original paper, it being thought that the abnormal was sufficient. This was another mistake on my part. A precise description was given in a later paper[4] as follows:

"In the normal person a wheal, white in the center, appears immediately, which in five minutes has changed to a yellowish wheal ⅓ to ½ inch (0.8 to 1.3 cm.) across, with definite edges and surrounded by a flare of erythema 1¼ to 1½ inches (3 to 3.8 cm.) in diameter. The wheal begins to fade in ten minutes, is faint in fifteen minutes and has disappeared in twenty minutes. Such a result is negative; the patient is insensitive to histamine."

The criteria for an abnormal response are criticized by Williams, especially my insistence upon the presence of pseudopods "which Lewis has shown to be due to the distribution of local lymphatics." True, of course, that pseudopods represent local lymphatics made visible by the histamine they are draining off. True, also, that I laid great stress on them. But I did so for a reason, the reason being

that since the same concentration of histamine will outline a lymphatic in one subject and not in another, it would appear reasonable to suppose that the one subject is more sensitive to histamine than the other. Therefore, I continue to lay stress upon the appearance of true pseudopods, having found that they represent a trustworthy guide to assessment of the test, provided that it is carried out with the quantity and concentration of solution which I have used. Flare is of secondary consideration—it appears in every subject in response to the intradermal injection of histamine, and its extent varies not only according to sensitivity but also with skin pigmentation, fair skin giving a larger flare than dark. The same applies to the wheal, the size of which depends to some degree also upon the quantity of fluid injected. I must insist, however, that these criteria are to be applied *only* when the test is performed with the quantity and concentration of solution which I have used because it was on that basis that they were worked out. They must not be assumed to apply equally well to some other technique, as the observations about to be recounted will demonstrate.

INVESTIGATIONS

In order to find out whether Williams is correct in his contention that the differences in technique employed by him could have little effect on the result, the following investigations were undertaken.

1. *Investigation to determine any variation in reaction as between different salts of histamine* (15 *unselected patients without vertigo*).

Williams used histamine diphosphate; I used histamine dihydrochloride. It seemed advisable, therefore, to determine whether there was any difference in reaction as between the two salts, the amount of base being the same.

In a consecutive series of 15 unselected patients (the number used by Williams) taken as they came into clinic, two intradermal injections were given on the volar surface of the right forearm one below the other and four inches apart. In one area was injected 0.1 cc. of a solution containing 0.0057 mg. of base in the form of histamine dihydrochloride (the original solution, which equals 1:17,544 of base); into the other area was injected 0.1 cc. of solution containing 0.0057 mg. of base in the form of histamine diphosphate (1:17,500 solution of base). The histamine dihydrochloride solution was prepared by diluting 1 cc. of a 1:1000 solution of the

salt ("Imido" Roche) with 9 cc. of physiological salt solution. The histamine diphosphate solution was prepared by diluting 1 cc. of a 1:10,000 solution of base (Abbott's histamine diphosphate 0.275 mg. per cc.) with 0.75 cc. of physiological salt solution. The tests were done in a closed room at a temperature of 70°-80° F. but we did not have the advantage of a constant temperature chamber. The results were read at intervals of 5, 10, 20 and 30 minutes. The criterion used by Williams for a pseudopodium has been adopted throughout, that it shall extend at least 1 cm. (3/8 inch) from the edge of the wheal.

Judging the results in terms of the number of pseudopodia produced, the dihydrochloride gave the same result as the diphosphate in 12 cases, a lesser result in 3 cases (1 large, 1 small pseudopod as against 5 small). If the over-all picture including flare and wheal is taken, the dihydrochloride produced a very slightly larger response than the diphosphate in 1 case, an equal response in 9 cases, a very slightly smaller reponse in 5 cases. There was thus very little difference in size of reactions, but where there was a difference the dihydrochloride gave the lesser response. Thus judging either by pseudopods only or by the over-all picture, the dihydrochloride gave a slightly smaller response than the diphosphate, but the difference was so small that it could not be regarded as significant. From these observations, it would appear that the *salt* of histamine used in performing the test has no bearing upon the result.

2. *Investigation to determine any variation in reaction as between different concentrations of base* (*the same* 15 *unselected patients without vertigo*).

At the same time as the injections were given into the right forearm for the previous investigations, an intradermal injection of 0.01 cc. of a 1:1000 solution of base in the form of diphosphate (Abbott's histamine diphosphate 2.75 mg. per cc.) was given into the volar surface of the left forearm. The results were read as before, using the dihydrochloride injection on the right forearm as the weak solution for comparison, that being the solution I used in the original work.

The results were that with the original weak solution four positive responses were obtained, while with the stronger solution used by Williams an additional five positive responses were obtained. Moreover, of the four patients who gave a positive response to both dilutions, three gave a larger response to the more concentrated as shown by thicker, more obvious pseudopods. In one case the response

was equal in number of pseudopods, and though they actually lasted longer with the weaker solution, with the stronger they were heavier and more marked. Thus there is a marked difference in response as between the two solutions, the more concentrated giving more than twice as many positives (9:4) in 15 unselected subjects.

3. *Investigation to determine any variation in reaction as between different concentrations of base in* 18 *consecutive patients having Ménière's syndrome.*

In Williams' series of 55 cases of "intrinsic allergy" on which he used his modification of the test, there are 18 Ménière cases. I therefore took 18 consecutive patients having Ménière's syndrome—for it is in Ménière's syndrome only of the four conditions discussed by Williams that any claim has been made for the test—and tested them, using on the right forearm my own method and on the left forearm that of Williams as in Investigation 2. Again pseudopods were determined according to Williams' criterion that they extend 1 cm. (3/8 inch) from the edge of the wheal. The results were that, out of the 18 patients, with the weaker solution 3 patients produced a total of 4 pseudopods, while with the stronger solution used by Williams 15 patients produced a total of 24 pseudopods. Nor do even these figures convey the whole picture, for with the more concentrated solution the pseudopods were in many cases unusually thick and well marked and persisted much longer, sometimes remaining virtually unchanged for 30 minutes, and in one case for 45 minutes. In general, too, the whole reaction was more severe, the flare usually being more extensive and long lasting and the wheal approximately the same size as with the weaker solution despite the smaller quantity of fluid used (one tenth the quantity). Incidentally, I have found it very difficult to be accurate in dealing with such small quantities of fluid as 0.01 cc.

It is thus evident that the concentration of the solution used makes a very considerable difference to the results; the more concentrated solution produced 15 positives as against 3 positives with the less concentrated. Williams' assumption that his variation could have little effect is therefore incorrect. It will also, I think, be evident why I have insisted upon the importance of pseudopodia as the index of a positive reaction rather than upon flare and wheal, under the conditions of test that I have described.

The Histamine Skin Test as a Diagnostic Measure. It was hoped originally that the histamine skin test would serve as a general indi-

cator for allergy, following the suggestion of Dzsinich and Galle.[3] This hope was dashed very early, when it was found that patients with a known specific sensitivity often gave a normal response to histamine intradermally. I corrected myself in this respect in a paper published in 1943 (footnote 7a)[4] and Farmer later pointed up the fallacy more substantially.[5]

In no other respect has the histamine skin test ever been suggested, by me, as a means of diagnosis. It was, and is, advocated in cases of Ménière's syndrome merely as a means of dividing cases of this syndrome into two groups, histamine sensitive (at first thought to be allergic) and histamine insensitive. But according to Williams, I have contended that "vasospastic and vasodilating types of allergy exist." This is not so. Certainly, I have spoken of allergy as being in vascular terms a vasodilator mechanism, but I have equally certainly never spoken of vasospastic allergy, which seems to me a contradiction in terms. Nor do I know of any evidence to suggest that vasospasm can be on an allergic basis. I fear he has mistaken my meaning. Indeed, it is quite evident that he has when he cites, as evidence of the uselessness of the test, two histamine-positive patients, one of whom turned out to have a brain tumor and the other a duodenal ulcer. That is entirely irrelevant. There is no reason why a histamine-sensitive patient should not develop a brain tumor or a duodenal ulcer. The histamine skin test does not make a diagnosis; it determines only whether the patient is sensitive to histamine or not.

The Validity of the Histamine Skin Test as a Guide to Therapy. With regard to Williams' second point of criticism, that the test is "valueless . . . as a guide to therapy," Williams' own 18 Ménière cases are, in the light of the observations described, not without significance. He states that in 17 of these patients a good result was obtained with nicotinic acid, although nine showed a positive reaction. That is to say, eight showed a negative reaction. These eight thus responded to treatment in the way that would be expected of them if my contentions as to mechanism have validity. As to the nine patients who showed a positive reaction, the probability is that most if not all were negative by my technique. Reference to Investigation 3 will show that out of 15 negatives by my technique, 12 were positive by Williams' technique—12 out of 15 or 8 out of 10. Thus of Williams' 9 positives, it appears that at least 7 and perhaps 8 would have been negative by my technique and even possibly the whole 9, since Williams' series is too small statistically to rule out such a chance happening. Again, therefore, the satisfactory response to nicotinic acid is not contradictory but is actually what would be

expected. Moreover, it is worthy of note that the one failure to treatment with nicotinic acid gave a positive reaction. If this was in fact a true positive, again the response to the treatment given is correct. A true histamine-positive patient should respond badly to nicotinic acid, but well to histamine desensitization. Perhaps histamine desensitization in this case would have produced a more satisfactory result.

CONCLUSION

I wish to insist on the point that the histamine skin test has been advocated by me for cases of Ménière's syndrome and for that condition alone. It is for this reason that the Ménière cases only in Williams' paper have been considered here. Whether the test has any application to the other conditions mentioned by Williams I do not know. What I have said and continue to say is that in cases of Ménière's syndrome it satisfactorily separates a small group of patients who are sensitive to histamine from a much larger group of patients who are insensitive, and that the effective treatment of these two groups is radically different. I have as yet found no reason to retract from this position. The test, of course, is not foolproof. There are absolute positive and absolute negative reactions which brook of no doubt, but in between are doubtful reactions which demand a little experience and discrimination for their correct interpretation. The histamine skin test is not alone in that however—any intradermal test requires the same.

The experience of investigating by this means, and treating according to the results obtained, more than 300 patients having Ménière's syndrome in the past six years has only strengthened my confidence in the test, and the figures given in published papers[1, 4, 6, 7] serve, I believe, to confirm it. Williams rests his criticism of the test on 18 Ménière cases only. Admittedly, numbers are not everything: more important is accurate observation. Unfortunately in this case the observations in the two series are not comparable because the method employed was not the same, and, as shown, the results obtained by the two methods are very different. Williams' adverse criticism of the test would therefore not seem to be justified as regards cases of Ménière's syndrome.

REPORT OF CASES

The validity of the histamine skin test as a guide to therapy is best demonstrated by specific examples. Here are two nicely contrasted cases, selected from several similar ones in my files.

CASE 1.—*P. P. 295/9. A Case of Ménière's Syndrome (Histamine Positive) Treated with Nicotinic Acid without Improvement, by Histamine Desensitization with Prompt Improvement.*

A man, aged 33 years, consulted me in August 1944, on account of attacks of vertigo which had been present for five and one half years. Frequency and severity had varied, but of late both had increased; he was having one or two severe attacks a week, often falling, and on one or two occasions had lost consciousness for a brief period. He was constantly unsteady, had frequent nausea; there was impaired hearing in the left ear of 25 per cent with intermittent tinnitus. In short, this was a case of severe Ménière attacks with only mild cochlear involvement. The histamine skin test was doubtfully positive (flare 1 3/4 inches, wheal 5/8 inch, 2 x 1/4 inch pseudopods), but a test with a double dose three days later was undoubtedly positive (flare 2 inches, wheal 5/8 inch, 2 x 1/2 inch pseudopods). There were no other findings of significance. Previous treatment had consisted of potassium chloride and a salt-free diet in 1942 without relief; recently of nicotinic acid orally, 300 mg. daily, which seemed to increase the severity of the attacks and gave him severe headache even when reduced to 150 mg. daily.

In consequence of the positive skin test, he was started on a course of histamine desensitization with very small increases in dosage. After the third dose (0.02 cc. of 1:10,000 histamine base) he had no more severe attacks, only occasional momentary unsteadiness, the tinnitus was improved and ultimately ceased, and hearing in the affected ear returned almost to normal. Then on January 2 and 3, 1945, he had two mild attacks, having finished his course of desensitization six weeks before and having had no treatment since. His histamine skin test was again strongly positive (it had been negative at the end of his first course) and he was started on a second course of injections, again with prompt relief of symptoms. He has had no attacks since then, an occasional unsteadiness only, and all cochlear disturbance has disappeared.

Here, then, is a patient with a positive skin test who on nicotinic acid was made worse, on histamine desensitization was promptly relieved, not only of his vestibular disturbance but of his cochlear as well, wherein he was lucky.

CASE 2—*P. P. 256/8A. A Case of Ménière's Syndrome (Histamine Negative) Treated with Histamine without Improvement, with Nicotinic Acid with Prompt Improvement.*

This case has been reported previously in full.[7] It is being used again here briefly because it affords so striking a contrast to Case 1 and is an even greater vindication of the validity of the histamine skin test as a guide to treatment.

A man, aged 34, first seen in June 1942, had an attack of vertigo with deafness and tinnitus four years previously. After a free interval of two years he had another attack followed by several more during the winter of 1940-41. Two intravenous histamine injections at this time "worked wonders" (the vasodilator effect, no doubt), though some subcutaneous injections immediately following were "not so good." However, he was free from attacks until three weeks before I saw him. At this time he had a sudden attack which knocked him out of a chair, lasted for 12 hours and was followed by daily severe attacks which seemed to be made worse by histamine, of which he had seven intravenous injections.

When first seen by me he was in status Meniericus, having been continuously dizzy for several days with frequent periods of exacerbation in which he had acute vertigo, great impairment of hearing in the right ear and severe tinnitus. He was vomiting at frequent intervals and was severely ill and dehydrated. On examination he had signs of irritation of the right vestibule (spontaneous nystagmus to the right, pointing error and fall to the left) with a hearing loss of mixed type in the right ear. The histamine skin test showed a normal response. All other examinations were normal.

He was given nicotinic acid intravenously daily in rapidly increasing doses up to 100 mg. for 15 days, after which he was taught to give himself daily intramuscular injections. As a result, he had only one more attack four days after starting the intravenous therapy and then mild attacks one month and three months later. By December 1943, his hearing had returned to normal and his tinnitus had ceased. Since then he has continued with nicotinic acid by mouth regularly, occasionally taking an intramuscular injection of 100 mg. if his tinnitus begins to return. This, he states, clears his head at once. He was last seen on March 10, 1945, having had no dizziness of any sort since September 1943 and only occasional "clogging" of the ear and tinnitus which is his signal for a temporary increase in dosage. His audiogram was normal.

Here is the reverse of Case 1, a patient with a normal (negative) histamine response in the skin who responded initially to histamine intravenously, presumably because of its vasodilator effect, who failed to respond two years later, but who responded excellently to nicotinic

acid and has continued to respond to it for three years. I have met this sequence of events on a number of occasions.

SUMMARY

1. The histamine skin test which I have advocated as a means of dividing cases of Ménière's syndrome into two groups has been criticized by Williams in a paper on the "intrinsic allergy syndrome." Certain investigations have therefore been undertaken to refute this criticism.

2. The method of performing the test as used by me and the criteria which were determined for its assessment have been recapitulated in detail, and some discrepancies in William's method of performing the test have been pointed out.

3. The results obtained with the two methods have been compared by testing both methods at the same time on each of a consecutive series of unselected patients. It was found 1) that different salts of histamine made no difference to the results providing the same quantity of base was used in the same concentration; 2) that different concentrations of base on the other hand made a great difference in the results, many more positive results being obtained with the higher dosage and higher concentration used by Williams than with the lower dosage and lower concentration used by me.

4. The implications of this in respect to the criticism levelled by Williams have been discussed.

5. It has been concluded that the statement of Williams that "skin tests with histamine seem valueless . . . as a guide to therapy" does not hold good on the evidence provided by him, and two illustrative cases have been cited to point up this conclusion.

127 EAST 70TH STREET.

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LXVIII

MIXED SALIVARY TUMOR IN THE RIGHT TONSIL FOSSA WITH NARCOLEPSY AND CATAPLEXY

CHARLES E. H. BATES, M.D.

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Ewing[1] says that the mixed tumor may be defined as a complex embryonal tumor of local origin which reproduces the normal development of the tissues and organs of the affected part. They may be classified according to the region in which they occur, as renal, genito-urinary, salivary and facial and mammary.

"The salivary and lacrimal glands are the seat of mixed tumors containing mesodermal derivatives and basal cell carcinoma and are probably derived from buccal ectoderm with a possible admixture from the maxillary periosteum or branchial cartilages.

"The present status of our knowledge of the origin of mixed tumors of the salivary glands may be summarized as follows:

"1. The endothelial origin has been disproved.

"2. No single source of the mixed tumors meets all the requirements. Some are distinctly adenomatous and probably arise from the acini and ducts of the gland in which they are well incorporated. Others are encapsulated or extra-glandular and take the form of basal-cell or adenoid cystic epithelioma. These probably arise from misplaced and occasionally embryonal portions of gland tissue. Branchial remnants may possibly be connected with this group.

"3. The derivation of mucous tissue and cartilage from gland epithelium has been satisfactorily proved and there is no necessity of including in the originating tissue any cartilaginous structures."

"Epithelial mixed tumors of the salivary glands are comparatively common, generally speaking. They occur at all ages but usually between 20 and 40 years. In several cases a quiescent or slowly growing tumor had existed from birth."[1]

"Both sexes are equally involved.

"According to Bohme and Kuttner 90 per cent of these tumors are parotid, ten per cent are submaxillary, and one per cent are sublingual.

"In the majority of cases a quiescent tumor has long preceded the development of the active growth. Very often the quiescent nodule was observed for from 8 to 10 years. Pailler reported an inactive period of 37 years and Wood, 53 years.

"Trauma rarely appears as a possible factor.

"Once established, active growth proceeds slowly, but varies with the histological type. The average duration of operative cases is about 8 years. A limitless growth is by no means a necessary attribute. Thus, in Martland's case, after 2 years of active growth, the tumor remained stationary for 13 years. The patient died of phthisis. This fact has a bearing on the therapeutic results of radium, which is of much value in this group of tumors, as well as on the wisdom of surgical removal, which is often followed by recurrences of increasing malignancy. On the other hand, some old tumors, becoming active, soon infiltrate the capsule and gland and even invade the lymph nodes in a few months. There are some indications that the addition of malignant properties may come from some secondary neoplastic process established in the adjoining gland, or by perforation of the tumor capsule.

"There are wide variations in the clinical behavior of the tumors. Occasionally it is progressive from the start. After surgical interference encapsulated growths do not, as a rule, recur but others are very prone to return at once or after an average interval of 2½ years or as late as 9 years.

"Successive recurrences with many operations have extended over 20 years. In the recurrent tumors the structure may remain constant, but more often it becomes increasingly cellular, atypical and malignant.

"Undisturbed tumors rarely invade lymph nodes, but after unsuccessful operations, while the recurrences are usually local the cervical nodes may be progressively involved."[1]

Goldsmith and Ireland[2] discussed mixed tumors of the salivary gland type occurring in the nose and throat. They reported six cases; four of these were in the palate, three extended over to the supratonsillar fossa, but were not in the tonsil fossa. They mention the work of Sonnenschein who reviewed the literature and found 50 cases with involvement of the soft palate. Complete surgical removal was the most satisfactory method of treatment in their series. Radiation as a primary treatment should not be considered. Prophylactic postoperative radiation may have some usefulness.

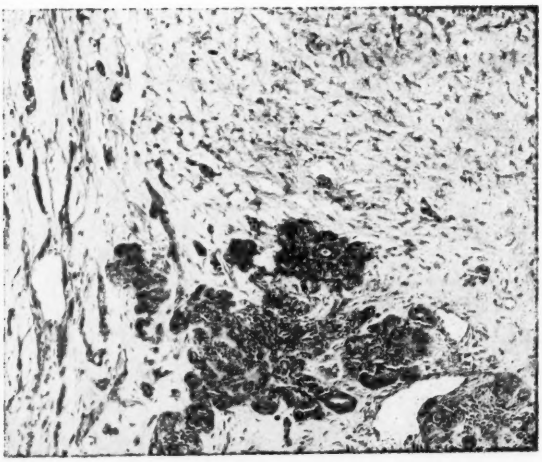

Fig. 1.—Photomicrograph showing islands of epithelium-like cells in gland-like arrangement scattered through a field of loose myxomatous stroma.

In December 1936, Prohovnik[3] of Chicago reported that a review of the literature of the years 1926 to 1936 showed only three cases reported of salivary gland tissue in the tonsil fossa: one by Neuman in May 1928, and another by Tillotson[4] in October 1930 and the third by Seydell[5] in March 1934. Up to December 1943 these are the only cases listed in the Index of the ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY[6] for the period of 1934 to 1943.

Prohovnik says the finding of salivary gland tissue in the tonsil fossa is so infrequent that its occurrence should be recorded for statistical purposes. He believes that, embryologically, the presence of aberrant glandular tissue in the tonsil fossa could be explained on the basis of an anlage of salivary gland tissue becoming misplaced. He says that after the complete removal of the tonsils, the surgeon on finding any soft tissue in the tonsil fossa should bear in mind the possible presence of salivary gland tissue and refrain from surgical intervention.

The present case is of Mr. H. G. aged 30, a grocer of Italian descent, who came in complaining of a desire to sleep all of the time. He reported that if he took a drink he became forgetful, and when

sleeping he had difficulty in getting his breath. On three occasions he had fallen down when laughing. The tumor mass was not mentioned until I found it on routine examination. He had had it for over three years but it had not grown any worse. Two other doctors told him it was an incompletely removed tonsil. (He had had a tonsillectomy and adenoidectomy at six years of age.) The only nasal complaint was occasional obstruction.

His weight had been 240 pounds, but at the present examination was 212 pounds. He had been having treatment with thyroid and pituitrin by another physician. He did not have headaches. He did not complain of any trouble with his eyes or his ears, had had no recent illnesses. He used liquor moderately.

Examination: The patient was a blond, overweight male. He appeared to be sleepy but did not look acutely ill. The conjunctiva was slightly injected. The nose was clear and the septum slightly irregular. The right antrum appeared cloudy on transillumination. The x-ray examination showed slight thickening of the ethmoid cells; the other sinuses were clear. The sella turcica was normal.

There was a large tumor mass of the right tonsil fossa, extending well up into the supratonsillar fossa. The mass was firm, not hard, lobulated at the top and at the posterior borders. The anterior pillar was broad and stretched. The uvula was pushed over and the general appearance was that of a large peritonsillar abscess.

The nasopharynx, the larynx and the ears were negative. There were no palpable cervical nodes.

On July 17, 1945, he was sent to St. Luke's Hospital for further work-up and biopsy of the mass. The blood chemistry was normal. The urine was normal. The blood count was normal. The basal metabolic rate was plus 19 per cent.

No cause for the narcolepsy and the cataplexy was found. Ten mg. of benzedrine sulphate three times a day definitely improved the narcolepsy.

On July 20, 1945, another physician and I operated and found an encapsulated tumor filling the entire tonsil fossa and definitely pushing the carotid sheath and contents well outwards, under pressure. We were able to remove the entire tumor with its capsule even though it broke apart during the procedure. The tumor was avascular, friable, rubbery, grayish-white and pearly in appearance.

The fossa was clean after the operation but large. We feel that the tumor was thoroughly removed.

Pathological Report. Gross: Examination shows a soft, grayish-white myxomatous tissue. The piece examined was about 1 by 2 cms. in diameter. Microscopic: Frozen and paraffin sections show a loose myxomatous stroma containing scattered stellate cells and a fine reticulum of fibrous tissue. In this ground substance there are islands of epithelium-like cells which are closely packed, but which have an occasional, indefinite gland-like arrangement. There are occasional mitotic figures.

Pathological Diagnosis. Mixed tumor of a salivary or mucous gland.

I saw the patient on August 9, 1945. He was back at work, feeling fine, and had no symptoms of narcolepsy.

I saw him again today, September 24, 1945, and he feels fine. There are no signs of recurrence. Pressure on the carotid sinus gives no symptoms.

This patient had a mixed tumor of the salivary type in the right tonsil fossa, with narcolepsy and cataplexy. The cause of the narcolepsy and the cataplexy is unexplained unless the pressure of the tumor on the carotid sheath affected the cerebral circulation. He was apparently cured by the removal of this large avascular tumor.

The literature does not mention tumors of the neck or pharynx as being a cause of narcolepsy. Several brain surgeons have been interviewed and they cannot explain the narcolepsy and cataplexy in this case. Was it due to interference with the carotid circulation, or to pressure on the sympathetics or even against the carotid body? No abnormality of the hypothalamic function was found.[7]

SUMMARY

A mixed salivary tumor of the tonsil fossa is reported. This patient also had narcolepsy and cataplexy, both of which disappeared after removal of the tumor. No similar case has been found reported in the literature, nor has any explanation been found as to the association of the tumor with the neurological condition.

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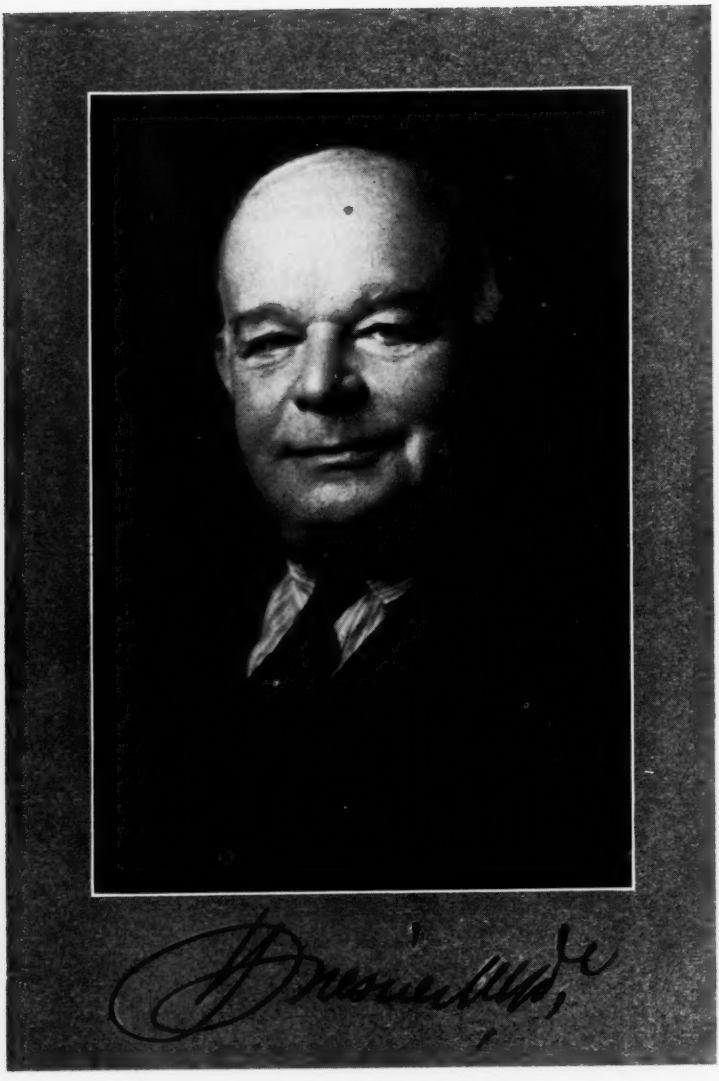

ISIDORE FRIESNER, M.D.

1874-1945

On September 8, 1945 there passed from our midst one of the truly great figures of modern American otology. At the time of his death, Dr. Isidore Friesner of New York City was 71 years of age. He had spent his entire professional life in New York City in the practice of his chosen specialty. His genial personality, his professional ability and acumen, his love of teaching the young and old alike, his devotion to his work and his whole-hearted zeal in any job he had to do endeared him to all medical men with whom he came in contact. Although he had for many years a large and active consulting practice, he was never too busy to assist any young practitioner who came to him for help. He really loved to teach others what knowledge he himself had acquired. For several years he gave courses on the intracranial complications of ear suppuration on the instructional program of the American Academy of Ophthalmology and Otolaryngology and on two occasions he conducted an ear course at the Los Angeles Study Club. He was on the editorial board of the Archives of Otolaryngology from the year of its inception. We have lost a true friend and a truly great teacher.

Dr. Friesner was born in New York City on July 25, 1874. He was graduated from the College of the City of New York in 1894. He received his M.D. degree from the Gross Medical School in Denver, Colorado, in 1901. He interned at the Bellvue and Presbyterian Hospitals in New York. After some postgraduate work with Dr. Pike at the Post-Graduate Hospital he began his study of otology with the late Dr. Wendell Phillips and with Dr. J. Clarence Sharp at the Presbyterian and the Manhattan Eye and Ear Hospitals.

Dr. Friesner was President of the American Otological Society in 1939, and in 1941 became its Secretary-Treasurer, which post he held at the time of his death. He was a former Vice-President and at the time of his death was on the Otological Consulting Board of the New York Society for the Hard of Hearing. He was a former Chief of the Ear Service at Mount Sinai Hospital and the President of its Medical Board for many years.

Dr. Friesner received a Phi Beta Kappa degree from the College of the City of New York. He was a member of the American Otological Society, the American Laryngological, Rhinological and Oto-

logical Society, the New York Otological Society, the New York Academy of Medicine, the American Academy of Ophthalmology and Otolaryngology and was a Fellow of the American College of Surgeons. He was a consulting otologist to the following hospitals: Mount Sinai, Beth Moses, Beth David, Beth El, Bronx, Flushing, Methodist of Brooklyn, and St. Joseph's Far Rockaway.

Together with Dr. Alfred Brown he wrote two books entitled "Labyrinth" and "Cerebellar Abscess." His many scientific contributions have enriched the literature of otolaryngology.

During the last ten years of his life his hobby was painting and he exhibited several times at the various Physicians' Art Exhibits. Otology has indeed experienced a great loss in the death of this man who was always in the forefront of otological practice and teaching during the years of its greatest expansion in this country. Dr. Friesner is survived by his widow, the former Laura Arnstein, and two brothers, Louis and Arthur.

GROVE.

Abstracts of Current Articles

EAR

The Influence of Pregnancy on Otosclerosis.

Barton, Richard T.: New England J. Med., Vol. 233, Oct. 11, 1945.

Careful study of the case records of 133 otosclerotic women who had experienced one or more pregnancies revealed that 72 per cent suffered hearing loss with the first pregnancy and 50 per cent with subsequent ones. Considerable attention is devoted to the controversial problem of abortion in this type of case, particularly to the experience of the German investigators. As the effect of pregnancy on otosclerosis is variable and unpredictable and the value of abortion inconstant and doubtful, the author feels that this procedure is never justified, especially as the disease is not dangerous to life. Similarly sterilization is considered as futile in controlling otosclerosis as it is impossible to prophesy deafness of progeny. In the series studied, patients had at least a 50 per cent chance of having successive pregnancies without damage to hearing.

HILL.

Tests for Unilateral Deafness.

Priest, Robert E.: Arch. Otolaryng. 42:138-143 (Aug.) 1945.

While conducting the Ear, Nose and Throat Clinic in an army hospital the author has examined many patients who claimed to have total unilateral loss of hearing. Some have had such loss and have refused to admit it. The unilaterally deaf soldier is a jeopardy to both himself and his unit.

Tests for unilateral deafness should be simple and as nearly absolute as possible. Care should be taken to prevent suspected malingerers from becoming wary. When the otologist discovers a malingerer he is tempted to show indignation. This should be avoided. He is only a fact finder and deals with only one phase of the patient's condition.

The examination routine finally adopted included the following: A careful history, examination of the ear drums, canals, nose,

nasopharynx, and pharynx, hearing of whispered and spoken voice, Rinne and Weber tests, test for tubal patency, bone and air conduction audiograms and serologic studies. The hearing tests were frequently repeated to demonstrate suspected inconsistencies. When unilateral deafness was claimed, or when the shadow curve suggested such loss, tests for unilateral deafness were applied.

These routinely included the following procedures: (1) shadow curve audiogram, (2) the Wells modification of the Stenger test, (3) the Lombard reading test, and (4) the Marx test. Certain other procedures were used as auxiliary tests, namely, (1) watch and tube test (2) Hummel double conversation test (3) bone and air conduction (Becker) (4) Teal test (5) Bárány caloric test.

Tests found unsuitable were those involving ostensible occlusion of the auditory canals.

HILDING.

Deafness: Its Causes and What Can Be Done About It.

Lurie, M. H.: Arch. Otolaryng. 42:144-146 (Aug.) 1945.

The author summarizes briefly the status of our present knowledge of deafness and its causes. He points out the extreme difficulty of experimental study. Results of animal experiments can be demonstrated histologically, but there is no way of determining the degree of hearing loss. Acute losses of hearing can be produced in man, but the effects upon the sense organ cannot be demonstrated. Treatment is generally not very successful. A notable exception is the treatment of otosclerosis by fenestration. The cause of this deafness is mechanical and can be by-passed with Lempert's operation. There are many causes of degenerative changes in the sense organ resulting in various degrees of impairment of hearing. For this nerve deafness there is no known specific treatment. The treatment of the patient must be done by others than otologists; namely, psychologists, teachers of lip reading and physical therapeutists. The hope of preventing nerve deafness and of restoring impaired hearing in these cases lies in continued research

HILDING.

NOSE

Nasal Congestion From Frequent Use of Privine Hydrochloride.

Feinberg, Samuel M., and Friedlander, Sidney: J. A. M. A. 128:1095 (Aug. 11) 1945.

Feinberg's and Friedlander's first clinical experience with privine hydrochloride intranasally in allergic and infectious rhinitis gave them the impression that it was the most effective vasoconstrictor available. The continued use of this drug in their practice, however, began to give increasing evidence that in addition to its vasoconstrictor action there was a congestive phase. In the last year or so, they state they have been impressed with the large number of patients in whom symptoms of nasal congestion have been aggravated or prolonged by the continued use of privine.

The number of patients, 75, is apparently sufficient to draw conclusions.

They mention the fact that the solution is isotonic and has a pH physiologically compatible with the nasal secretions and does not produce irritation or other disagreeable symptoms. However, prolonged use produces congestion of the mucosa. This, they believe, is due to vasodilatation as a reaction and may be prolonged, to a degree, to resemble an allergic reaction.

CARMODY.

Bernoulli's Theorem and Upper Respiratory Drainage.

Colson, William Z.: Laryngoscope 55:444-462 (Aug.) 1945.

The influence of the respiratory act and nose blowing on sinus drainage has not been accorded the attention it deserves according to Colson. He applied to the nose the principles expounded by Bernoulli 200 years ago that rapidly moving streams of air or liquids exert a pulling or suction effect on the adjacent environment.

Colson's results were attained on sagittal sections of human skulls reconstructed so that the effect of air streams along the middle meatus was noted on a water manometer connected with the antrum.

In one skull the author reconstructed the middle meatus so that the approach to the maxillary ostium was narrowed and this resulted in an increase in the suction within the sinus up to twenty millimeters.

Colson concluded as a result of his studies that no suction effect is attained in cases of atrophic rhinitis or in those individuals who have been subjected to intranasal surgery which over-ventilated the nasal cavities.

He warns against overuse of shrinking drops which temporarily disturb the stream lining approach to the sinus ostia.

He feels that common acceptance of the fact that the Bernoulli principles are effective in sinus drainage would lessen somewhat the importance of the cilia.

VAN ALYEA.

MISCELLANEOUS

Penicillin by Intramuscular Infusion.

Turton, M. D.: British M. J., Sept. 1, 1945, p. 283.

This article summarizes the experiences of treating 30 patients with continuous intramuscular infusion, with attention focused on three points: whether the method was preferred by the patient to intermittent injection, whether it was convenient to the medical officer, whether there were any ill effects from its use.

Technique. A drip was not set up unless it seemed likely that it would be required for at least 30 days, and unless it had been preceded by a course of intermittent injections. The majority of drips were set up within a week of wounding with the men still in an acute condition.

A drip was set up in seven to fifteen minutes and checked from one hour to three hours later. After that the nursing staff was responsible for watching and refilling. The needles were changed when indicated, some being left in situ as long as seven days.

Patients' preference. Twenty-four of the 30 patients emphatically preferred this method to the injections, the commonest cause of drip preference being undisturbed sleep. Fear of injections and pain were less common causes.

Of the six who preferred the injections the chief reasons were that the injections were over quickly while the drip needle was always present and, though not painful, could be felt, and movement was hampered somewhat.

Convenience of use. The main difficulty in using the drip was the maintenance of a slow and steady supply of penicillin. The com-

mon cause of an irregular flow was a leak at the air capillary owing to the rubber splitting or a bung which did not fit perfectly. A striking feature was that if there were no technical difficulties, a drip would run to time almost exactly with a minimum of interference.

Ill effects. Fifteen patients admitted to some tenderness on firm palpation over the needle site after removal, but pain was not a feature in any instance. In three cases very slight redness and in one case an area of moderate redness were noticed. The effectiveness of the treatment was demonstrated by measurement of the blood penicillin levels, by the disappearance of gram-positive organisms from the wounds, and a steady progress of the patients toward recovery.

The general impression at the end of the series was that, in a hospital where there are a practiced operator and several nurses well acquainted with the technique, the continuous intravenous infusion is the method of choice for the patient and no more laborious for the staff than the intermittent injection.

SCHALL.

Local Use of Penicillin in Infections of the Ear, Nose and Throat.

Woodward, Fletcher D., and Holt, Thomas: J. A. M. A. 129:589 (Oct. 27) 1945.

Evaluation of penicillin was made in a moderately large clinic, and the results are well tabaluted as to disease entity and infectious organisms. In evaluating the results the authors take into account the possibility of other treatment giving the same results and it must be further noted that many otorhinolaryngological conditions recover spontaneously within the time limits given in the tables. We have all seen the same results with many other methods of treatment or with other drugs.

The authors call attention to the fact that many of the conditions treated are caused by organisms resistant to penicillin and in that case, we can only hope to affect those organisms which are nonresistant, so that we may give the body a chance to overcome the other invaders.

CARMODY.

Control of Air Borne Infection.

Editorial, J. A. M. A. 129:552 (Oct. 20) 1945.

The increase of respiratory disease, which is probably largely air-borne, in the war years is probably largely due to over-crowding on transportation systems as suggested by Stuart Mudd. Further-

more, Mudd estimates that over 225,000,000 person days were lost to American industry in 1943. This represents a waste of 740,000 persons working for a year.

While droplet infection has been demonstrated, this editorial quoted Wellses as proof.

The oiling of floors and bedclothes in barracks occupied by men in service reduced bacterial count by over 90 per cent.

Harris and Stokes are quoted as using the propylene glycol vapors in bactericidal concentration in wards of a children's convalescent home and found respiratory infection much reduced over control wards.

Ultraviolet irradiation as used by Robertson and her associates reduced cross infection in infant wards as was found by Wheeler and his associates in a naval training center.

The closing paragraph of this editorial is quoted in full:

"The practical utility of any control measure predicated on the reduction of the bacterial content of the air will depend on whether or not a large or a small proportion of respiratory disease is air borne. An increased body of evidence indicates that the amount of air borne infection is greater than was formerly believed. The methods thus far developed for the reduction of the bacterial content of living spaces constitute an important contribution to the total problem of control of respiratory diseases. Their practical application presents a number of problems the solution of which will call for cooperation of such specialists as physicians, engineers, architects, air conditioning engineers, and manufacturers of special apparatus."

CARMODY.

The Importance of Functional Examination of the Eighth Nerves in Brain Tumor.

Riesco, J. S., and Fernandez, C.: Rev. de Otorrlaring. 4:181-314 (Dec.) 1944.

The authors report their experience with functional examination of the eighth pair of nerves in 220 cases referred by the Neurosurgical Institute of Salvador Hospital of Santiago, Chile. In this group there were 76 cases of intracranial tumor verified by operation. The findings and interpretations of the labyrinthine examinations are given.

In a preface there are a few generalizations which must be kept in mind. These refer to the fallacy of interpretation by formula

and stress the fact that there is much to be learned of the anatomy and the physiology of the labyrinth. Consequently the otologist who accumulates a large experience through careful and patient study of individual cases will acquire a greater accuracy than one who carries out the technicalities of the examination and reports his findings according to generally accepted formulae.

Although the labyrinth is not affected by tumor of the anterior and middle fossae, the examination in such cases is not always negative but may show abnormal responses due to the effect of intracranial hypertension on the membranous labyrinth, rather than to degeneration or compression of the nerve root or its nucleus. Typical of this condition is a patient with tinnitus, slight deafness of the perceptive type, vertigo, spontaneous nystagmus, and vestibular hyperexcitability without any localizing lesion disclosed by neurological examination.

In their summary three case reports are selected which illustrate the difficulties encountered in correct interpretation of functional examinations.

CASE 1. Female; age 42. Her illness began with deafness of the left ear one year previously. Following this there were dizzy spells, nausea, vomiting, and occipital headaches; and later there was diminished vision. The authors attach importance to the sequence of the appearance of symptoms, namely primary auditory symptoms and subsequent neurologic findings. Examination showed no response from the left labyrinth. Examination of the right labyrinth revealed the following: (1) Postcaloric dissociation of nystagmus and vertigo. (2) Vestibular hyperexcitability except for absence of vertigo. A diagnosis of left cerebellopontine angle tumor was made. The tentative diagnosis made in the Neurosurgical Institute before referring the patient for functional examination was left temporal lobe tumor or tumor of the cerebellar peduncle.

In making a diagnosis of left angle tumor, the authors record the reasons as follows: (1) Absence of cochlear and vestibular responses on the left side. (2) Spontaneous vestibular signs of central origin, such as bilateral nystagmus, horizontal to the right and rotary to the left. (3) Induced signs of central origin, such as dissociation of nystagmus and past-pointing and absence of vertigo. (4) Chronological order of the symptoms, namely deafness and vertigo, followed by diplopia and diminished vision.

During operation a large epidermoid tumor was found which occupied the left cerebellar fossa and displaced the whole hemisphere, the pons and the medulla to the right.

Although the preoperative diagnosis did not include the possibility of a secondary tumor invading the cerebellopontine angle, it is important to note that the pathology was definitely localized by functional examination of the eighth nerve. The surgeons were prevailed upon to explore this area, even though in the Neurosurgical Institute they had previously rejected the diagnosis of a lesion in the posterior fossa because of the presence of papillary edema and the absence of seventh nerve involvement.

CASE 2. J. S., age 14. This patient's illness was diagnosed in Neurosurgical Institute as intracranial hypertension syndrome, cerebellar syndrome, and diplopia. The cochlear examination was normal. The vestibular examination was normal except for two signs of a central lesion: (1) spontaneous horizontal nystagmus changing to vertical when looking up; (2) nystagmus of large amplitude but no vertigo following caloric stimulation.

In the interpretation of these findings the authors state that a diagnosis of posterior fossa lesion is warranted and specifically define it as one which compresses and irritates the central vestibular zone without destroying or invading it. Autopsy showed the presence of a large medulloblastoma situated in the inferior vermis of the cerebellum which compressed the medulla and the pons.

Past-pointing as an aid to diagnosis is discussed. The authors refer to the generally-accepted view that the past-pointing due to vestibular disease and that due to cerebellar disease may be differentiated through caloric and rotatory stimuli. It is generally believed that the vestibular tests are capable of altering spontaneous past-pointing due to vestibular disease, while in cerebellar disease there may be no past-pointing at all after caloric and rotatory stimulation. If past-pointing is present and within normal limits, then the cerebellum is not involved. In this particular case the past-pointing after stimulation was perfectly normal. Their conclusion is that signs of central disease following caloric and rotatory stimuli must be considered of relative value only and that no single finding should be accepted as having absolute diagnostic significance.

CASE 3. J. D., female, age 28. For four months previous to admission to the Neurosurgical Institute she complained of symptoms indicating intracranial hypertension, viz: severe headache, vomiting, and vertigo. Following these symptoms her vision became blurred.

She was referred for functional examination of the eighth nerve without a tentative diagnosis or a localization of the lesion. The patient had normal cochlear and vestibular findings. An exploratory operation showed the presence of a tumor completely obstructing the aquequct of Sylvius and protruding into the fourth ventricle. The histological diagnosis was Cysticercus. Explanation of the symptoms and more particularly the absence of symptoms which might be expected in such a lesion is of great interest. The absence of vestibular findings is perhaps due to the fact that the vestibular nuclei are located in the lower portion of the fourth ventricle below the area affected by the tumor. However, the tumor was in the area of the vestibulo-ocular tracts and nuclei of the third, fourth, and sixth nerves. The fact that vestibular nystagmus can be induced experimentally, even in the absence of both labyrinths, by stimulation of the vestibular nuclei shows that the mechanism of origin is located somewhere in the central nervous system. There is, however, no proof of its exact location; nor is there general agreement as to the origin of either the slow or fast component of the nystagmus.

The authors are of the opinion that the nerve tracts from the vestibular nuclei to the oculomotor nuclei which induce nystagmus are not definitely known. Although the posterior longitudinal bundles are generally assumed to perform this function, Lorento de Nó has shown that nystagmus can be produced after section of both bundles.

The tumor in this patient which obstructed the aqueduct of Sylvius and increased pressure on the floor of the fourth ventricle undoubtedly affected the posterior longitudinal bundles, yet there was no spontaneous nystagmus. The nystagmus induced by caloric and rotatory stimulation was absolutely normal.

The above facts illustrate the need for more exact knowledge of the anatomy and physiology of the central vestibular tracts and nuclei.

The author's conclusions are summed up as follows:

1. Lack of complete knowledge of the anatomy and the physiology of the vestibular pathways makes each isolated finding in the functional examination of only relative importance. Long experience and close association with the neurosurgeon and pathologist will lend greater interpretive value to individual signs and symptoms.

2. Lesions of the eighth nerve may be diagnosed as central or peripheral and destructive or due to irritation, but one must beware of precise localizing diagnoses.

3. The role of the otologist is one of collaboration with neurologist and neurosurgeon.

HIGBEE.

The Therapy of Histamine and Nicotinic Acid.

Shea, John J.: Laryngoscope 55:325-336 (July) 1945.

Shea enumerates the conditions in which the vasodilator drugs, histamine and nicotinic acid have proven effective.

Perhaps the most outstanding relief is attained in those cases of sudden severe unilateral headache known as histaminic cephalalgia. The treatment consists of subcutaneous injections twice daily of histamine acid phosphate for a period of from ten days to three weeks. The initial dose is 0.25 cc. with an increase of 0.05 cc. each dose until 1 cc. is reached. Future attacks are prevented by adequate maintenance doses.

The acute symptoms of Ménière's syndrome, vertigo, nausea, vomiting and tinnitus may be relieved by subcutaneous or intravenous histamine injections and its administration is continued along with other recognized measures. The same type of management applies to the treatment of allergy.

Shea discusses also the use of nicotinic acid, nicotinamide and hapamine. Nicotinamide is especially indicated in pellagra patients and in those suffering from Vincent's angina or other ulcerated lesions of the mouth and throat. Hapamine, a combination of histamine and globulin injected in increasing amounts is thought to alleviate allergic symptoms by the formation of (histamine) antibodies which are released to neutralize the histamine present when the patient comes in contact with a substance to which he is susceptible.

The initial dose of hapamine should be 0.01 to 0.02 cc., intradermally. If little or no reaction occurs, 0.05 to 0.1 cc. can be given subcutaneously and similar treatments given every four or five days. The dosage can be increased by 0.05 cc. to 0.1 cc. at each injection until 1 to 1.5 cc. is being given at each dose. If tolerance is noted, dosage should be materially reduced, or treatment withheld for two weeks, after which treatment is resumed with a small dose (0.05 to 0.1 cc.) and the schedule of increase followed as recommended above.

VAN ALYEA.

Some Experience with Small Dosage Dust and Pollen Therapy.

Hansel, French K.: Southern M. J. 38:608-612 (Sept.) 1945.

The frequency of positive skin reactions to house dust varies from 25 to 96 per cent among different observers. These variations may be accounted for, however, upon the basis of differences in technic, test extracts and the interpretation of the reactions. Dust extracts are usually irritating to the skin, especially in dilutions of 1-10 or stronger.

House dust contains many known allergens to which the patient may be sensitive. The chief constituents consist of cotton, flax, jute, wool, silk, six or more animal hairs, three or more feathers, glue, kapok, orris root, pyrethrum and tobacco.

In view of the fact that there is no standardized technic and no plan of selection of the materials for the preparation of house dust extracts, there must be a very significant variation in the skin reactability, effectiveness, dosage and consequently the results obtained in treatment.

On the basis of what we know about house dust and its constituents, we have prepared stock extracts with the following ingredients. Parts of a number of vacuum cleaner sweepings, old mattress stuffing, automoible upholstery vacuum collections, kapok, feathers, jute and ozite. Specific animal hairs, silk, pyrethrum, tobacco or specific environment dusts were added separately when indicated. In some instances an extract of old feed mill dust which consists almost entirely of molds, such as that reported by Wittich, was used either alone or added to the stock dust extract.

In the diagnosis of hay fever the skin tests to pollen extracts are very reliable. The occurrence of hay fever in the absence of positive skin reactions is very rare.

During the past six years we have employed the coseasonal method of treatment in practically all the cases of tree and grass allergies with most satisfactory results.

For the most satisfactory results in hay fever treatment, complete skin testing should be performed and particular attention must be directed to the control of complicating sensitivities or manifestations such as those resulting from dust, molds and foods.

TAYLOR.

Atopy to Simple Chemical Compounds—Sulfonechloramides.

Feinberg, Samuel M., and Watrous, Robert M.: J. Allergy, Sept. 1945.

Drs. Feinberg and Watrous have undertaken a study to determine the sensitiveness of certain workers who are exposed to chloramine-T and halazone and other allied organic substances. Their attention had been called to the fact that certain workers in factories where these substances were used had become so sensitive to the substances that they would have symptoms of asthma, rhinitis, tracheitis, bronchitis, conjunctivitis, keratitis and follicular dermatitis, even though the sensitized persons in some instances were stationed in buildings three hundred yards away from the factory in which the chloramine-T was being used. When the wind blew in their direction, some of these symptoms were likely to occur.

It was natural for them to question whether they were dealing with a pure chemical irritant of sufficient intensity to create these symptoms or whether the person in whom the symptoms occurred had become definitely sensitive to them, as any allergic individual may become sensitive to a certain specific allergen. It was known that certain chemical irritants, such as sulfur dioxide, gasoline fumes and chlorine could produce atopic symptoms as nonspecific excitants, and it was logical to believe that the chloramides acted in much the same manner.

From a history of some of these workmen, it appeared that at first there was just a slight irritation in the bronchial tree after exposure to a fairly large amount of one of the agents, but later the slightest bit of dust that contained some of the agents would precipitate rather severe symptoms. Finally it was found that some of the men were positively unable to work anywhere in the vicinity of halazone or chloramine-T without danger of asthmatic seizures, rhinitis or some of the other symptoms mentioned.

Skin testing was then done, using dilutions of 1:100,000 of chloramine-T and halazone. This was done by the scratch method to determine wheal formation and a high percentage of these tests proved positive, whereas numerous control subjects failed to react to even concentrated solutions by scratch tests and to endermic testing in concentrations as high as 1:1,000. Both of these compounds behaved as true atopens. Eight of the group tested showed strong positive reactions to chloramine-T and this made them wonder whether, first, the case histories which had been very suggestive had not been actually exaggerated by the patients and, second, whether the scratch test may fail to diagnose all the cases of clinical sensitivity.

A dermal test could possibly give a positive reaction in some of those who were actually recorded as negative.

Efforts at desensitization proved that the behavior of these atopens is identical with that found in desensitization with atopens of high molecular weight. They also concluded that individuals with atopical constitutions are more likely to acquire such sensitivity, and since this fact was brought out very definitely it was thought wise that persons with a history of personal or familial atopy should not be accepted for employment in the particular branch of the factory where these agents are present.

McLAURIN.

Skin Sensitivity in the Aged—Fatality Following Intradermal Tests.

Wiseman, Joseph R., and McCarthy-Brough, Marguerite P.: J. Allergy, Sept., 1945.

The two authors of this paper bring out the fact that preconceived ideas regarding diminished sensitivity of skin of old people are erroneous. They quote Fineberg as stating, "An atrophic skin, a skin with poor circulation or the skin of the aged may be so diminished in reactivity that what would be ordinarily moderate reactions may become negative." They further quote Tuft as stating, "Especially in older individuals or in those who have had their condition for some time, the skin is likely to be the nonreactive type."

The authors' patient was a woman 78 years old who had showed marked positive reactions to many of the allergens to which she was tested. In the previous year, this same patient had been tested with similar extracts and had received dust and vaccine injections of fairly large doses and had tolerated such injections without difficulty. A year later when she was tested again, there was a fatal result. Within five minutes after the tests had been used and a similar treatment injection of house dust was given she developed a cough, followed by asthma, cyanosis, and finally collapse. Every effort at stimulation and artificial respiration was used, but the patient expired 15 minutes after the skin tests were inserted. An autopsy was not done.

The authors conclude that even though there are atrophic changes in the skin of the aged, the skin may react very acutely to tests. The reaction in the individual probably depends upon sensitivity of the skin, organs, and tissues. In this case, the allergic con-

dition had existed for 74 years and yet it did not render the skin nonreactive or diminish its sensitivity. They concluded their observations in this case by stating, "The aged require the same meticulous care in testing and treatment as patients of any age group."

McLaurin.

Emergencies In the Allergist's Practice.

Waldbott, George L.: J. A. M. A. 128:1205 (Aug. 25) 1945.

In this paper attention is called to the fact that the allergic patient is much more sensitive to drugs as well as allergens, whether the mucosa or the deeper tissues are exposed to attack. Allergic shock may be the result of idiosyncrasy or physical shock.

The author lays some stress on the function of a small vein in giving a hypodermic injection. While this may produce shock, especially if near a nerve or plexus of nerves, one cannot help but think of the possibility of an air embolus or even foreign particles in the injected solution, or of the apparent incompatibility of drugs as chloroform and epinephrine.

Carmody.

Gastroscopic Studies in Naval Personnel with Chronic Seasickness.

Benedict, Edward B., and Schwab, Robert S.: New England J. Med., Vol. 233, Aug. 23, 1945.

Fifty per cent of a series of 150 cases of chronic seasickness presented x-ray evidence of hypersecretion, loss of gastric motility and spasm of the pylorus, as well as thickened gastric sugar. Twenty-two of these patients were subjected to gastroscopy with essentially normal findings. The author's opinion is that seasickness does not usually cause changes in the gastric mucosa.

Hill.

Medical Progress. Endocopy.

Benedict, Edward G.: New England J. Med., Vol. 232, 20-21, May 17 and 24, 1945.

This article, one of a series devoted to Medical Progress, is a very complete review of recent developments in bronchoscopy, esophagoscopy, gastroscopy and peritoneoscopy, compiled from the literature. It quotes extensively from the field of thoracic surgery.

Hill.

Books Received

Investigations Concerning the Functions of the Lower Respiratory Tract.

By Truls Leegaard. French and German Summaries. Paper. Pp. 148, with 25 figures in the text and 24 plates. Oslo, A. W. Broggers Boktrykkeri A/S, 1944.

This monograph first reviews the more important investigations into the physiology of the lower air passages dealing with absorption and expectoration. These are considered on their merits and the reasons for some inconclusive deductions are pointed out.

The author's own work is directed to the study of the movement of secretion in the trachea and bronchi and in the processes of secretion and absorption.

Without going into the evidence for his conclusions which is voluminously dealt with in the monograph, these may be said to be: 1) that iodized oils injected into the bronchial tree are absorbed to a very limited degree by the membranes of the respiratory tract; 2) that they are rapidly eliminated by ciliary movement which carries them to the esophagus without the intervention of cough and that their rapid absorption takes place in the stomach; 3) that blood on the contrary becomes hemolyzed and is for the most part taken up by the lung tissue. "Only a very small proportion of the phagocytised blood is conveyed with the macrophages out into the bronchial tree and carried away."

The material is freely illustrated with photographs, photomicrographs and roentgenographs of the lungs of experimental animals.

Hayfever Plants: Their Appearance, Distribution, Time of Flowering and Their Role In Hayfever, with Special References to North America.

By Roger P. Wodehouse, Ph.D., Associate Director of Research in Allergy, Lederle Laboratories, Pearl River, New York. Vol. 15, a New Series of Plant Science Books, Frans Verdoorn, editor. Buckram. Pp. 245, with 73 illustrations. Waltham, Mass., the Chronica Botanica Co.; New York, G. E. Stechert and Co., 1945. (Price $4.75)

This monograph is a comprehensive dissertation on the botanical aspects of hay fever. The first chapter deals with types of flowers and their action in the cause of hay fever. Laboratory methods and apparatus are discussed and there is a complete list of publica-

tions dealing with the flora of the various districts of the United States.

There follow encyclopedic descriptions of individual plants in their botanical groupings. Most of them are illustrated.

The final section of the book deals with the regional distribution of hay fever plants and contains a complete set of very useful tables constructed to show at a glance not only the flowering period of each plant but the months and weeks of their greatest prevalence.

A very useful manual.

Notices

CASSELBERRY AWARD OF THE AMERICAN LARYNGOLOGICAL ASSOCIATION

A sum of money having accrued from the Casselberry Fund of the American Laryngological Association, a prize will be offered in 1946 for original investigation in the art and science of laryngology or rhinology. Theses must be in the hands of the Secretary, Dr. Arthur W. Proetz, 1010 Beaumont Building, St. Louis 8, Missouri, before March 1, 1946.

AMERICAN BOARD OF OTOLARYNGOLOGY

The next examination of the American Board of Otolaryngology will be held in Chicago at the Palmer House from May 22 to May 25, 1946. All communications should be addressed to the Secretary, Dr. Dean M. Lierle, University Hospital, Iowa City, Iowa.

BACK ISSUES OF THE ANNALS

At the urgent request of foreign subscribers, who desire to complete their files, the Annals wishes to obtain copies of the following issues now out of print: March 1940, December, 1940, March 1943, June 1943, March 1944, September 1944, March 1945. $1.50 per copy will be paid for any of these issues returned to us. They should be sent together with a memorandum of the sender's name and address to the Annals Publishing Co., 7200 Wydown Blvd., St. Louis 5, Mo.

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Sections:

Eastern—Chairman: Dr. Philip E. Meltzer, 20 Charlesgate W., Boston, Mass.
Meeting: Hotel Statler, Boston, Mass., Jan. 9, 1946.
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Western—Chairman: Dr. Clarence A. Veasey, Jr., 407 Riverside Dr., Spokane, Wash.
Meeting: Elks' Club, Los Angeles, Calif., Jan. 26-27, 1946.

American Medical Association, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia 2, Pa.
Secretary: Dr. Fletcher D. Woodward, 104 E. Market St., Charlottesville, Va.
Meeting: San Francisco, Calif., July 1-5, 1946.

American Otological Society

President: Dr. Gordon Berry, 36 Pleasant St., Worcester, Mass.
Secretary: Dr. Gordon D. Hoople, Medical Arts Bldg., Syracuse 3, N. Y.
Meeting: Drake Hotel, Chicago, Ill., May 31-June 1, 1946.

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